SOIL ECOLOGY SOCIETY
NINTH BIANNUAL
INTERNATIONAL CONFERENCE

Soil
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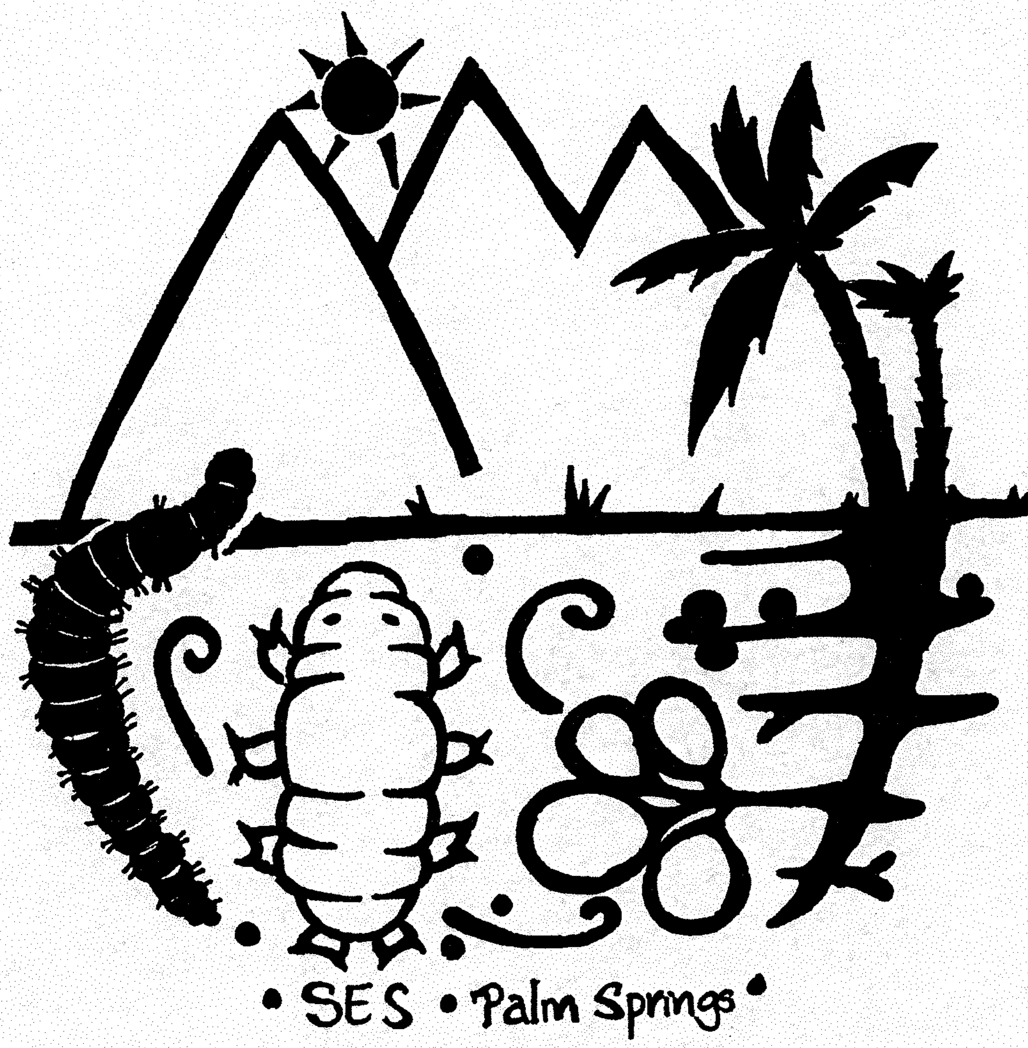
Society



INVASIVE SPECIES AND SOIL ECOLOGY

The Doral Resort
Palm Springs, California
May 11-14, 2003

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Soil Ecology Society

Invasive Species and Soil Ecology

The Doral Resort
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11-14 May, 2003

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CONFERENCE OVERVIEW

Welcome to the ninth biannual 2003 Soil Ecology Conference here in Palm Springs, California. Palm Springs lies in the Coachella Valley, a portion of the Mojave Desert lying near or below sea level. We have planned a Sunday evening introductory talk by Mike Allen to discuss soil ecology, endangered species, and other issues in the Valley. We hope that you will be able to participate in the field trip to Joshua Tree National Park and/or take your own trips to local palm oases and preserves.

The theme of the 2003 meeting is "Invasive Species and Soil Ecology." We have invited four keynote speakers to address this theme. David Wardle will discuss the impacts of invasive large animals on soil ecology; Patrick Bohlen's topic is impacts of invasive earthworms; Mary Firestone will cover the effects of invasive plants on soil microbial functioning, and David Rizzo will discuss the soil-borne *Phytophthora ramorum* and sudden oak death. The response to the call for abstracts about this theme has been remarkable. We have some 30 contributed talks and posters on invasive organisms and their impacts, or impacts of invasive plants on soil functioning. A total of more than 137 abstracts were submitted, with a range of topics from mycorrhizae to soil food webs to soil C and N cycling.

The Soil Ecology Society

The Soil Ecology Society (SES) is an international organization of researchers, students, environmental professionals, educators, and others interested in the advancement and promotion of soil biology and ecology. This arena includes, but is not limited to, soil invertebrate ecology, soil microbial ecology, soil science, soil chemistry and physics, biogeochemistry and nutrient cycling, root and rhizosphere ecology, plant pathology, mycorrhizal studies, and hydrologic interactions with soil processes and organisms. The SES holds a biennial conference which addresses contemporary issues in the field of soil ecology, and which provides a forum for ecologists, soil scientists, and members of related disciplines to present original research results, participate in meeting symposia and workshops, and identify priorities for future research.

Posters

Posters may be set up Sunday evening or Monday morning in Mesquite C. The poster session and mixer will be on Monday at 4:30-7:00, when poster presenters will stand with their posters. Posters will be left up for viewing through the end of the sessions but must be taken down by Wednesday morning, 10:30 am.

Oral Presentations

LCD projectors, PC and MacIntosh computers, slide projectors, and overhead transparency projectors will be available. If you are doing a Powerpoint presentation, please leave your compact disk at the registration table on Sunday evening. Talks will be loaded onto computers prior to the session. Slide previewing may be done in Mesquite C, where a computer and slide projector will be set up.

Election for SES Officers

A ballot will be provided with your registration materials to vote for president-elect and secretary/newsletter editor. All members of SES in attendance should vote. You are a member if you have registered for the conference. Students are considered full members, and should join in the vote. The ballots are due Tuesday noon, and should be left at the registration desk. The results of the election will be announced at the barbecue Tuesday evening.

Awards

Students who have requested to be evaluated for the poster and oral competition will be judged by Tuesday afternoon. The judges will confer and decide on awards in time to make announcements at the Tuesday evening Awards Barbecue. At that time the Parkinson Travel Award winners will be announced, and finally the winner of the Professional Achievement Award. The Awards Barbecue is a ticketed event, but everyone may attend the awards after dinner, and purchase drinks at the bar.

Logistics

The sessions will be held in the Doral Resort, where most guests will also be staying. The Sunday evening mixer will be in the Vista Room, and coffee breaks will be in the Mesquite Foyer. Coffee, tea, lemonade, iced tea, sodas, and breakfast snacks will be served during breaks. Talks will be held in Mesquite AB and DE, and posters will be displayed in Mesquite C. Lunches are part of the registration costs, and all registrants are invited to a buffet luncheon on Monday and Tuesday outside on the Veranda. The Southwestern awards barbecue will be held poolside on Tuesday evening

A breakfast buffet is served daily, or you can order a la carte (not included with registration). The hotel restaurant serves dinner, or you can take advantage of the many area restaurants (several at 1.5 mi on the corner of Landau and Ramon Blvd, or 4 miles to downtown Palm Springs, along Palm Canyon Drive). Grocery stores are located on Vista Chino 3 miles west of the hotel. The Doral offers shuttle service into downtown Palm Springs, but you must get a taxi back. See the brochure in your room for lists of restaurants, a map, and sightseeing.

Field Trip to Joshua Tree National Park

The field trip to Joshua Tree National Park will depart at 11:30 am on May 14 from the hotel lobby. A few extra seats are available on the bus and can be purchased at the registration desk. For those who have field trip tickets, box lunches will be provided by the hotel. We will have water on the bus. Individuals with their own automobiles are welcome to caravan with us. We can provide you with an itinerary, or set your own. The Park entrance fee is $10.00 for passenger cars. For everyone coming to the park, be sure to bring your hats, water, sunscreen or long sleeves. Temperatures can range from very warm (90° F and higher) to cool (50-60°) at high elevations in the late afternoon (4000-5000 ft.). We will return to the hotel by 6:00 pm.

SUMMARY SCHEDULE

Sunday, May 11

1:00 - 7:00 pm	REGISTRATION (*Lobby by Vista Room*)
4:30 - 6:00 pm	Mixer (snacks and no-host bar) (*Vista Room*)
6:00 - 6:45 pm	Introductory Speaker – Mike Allen (*Mesquite AB*)
	Supper on your own

Monday, May 12

7:30 am - 5:00 pm	REGISTRATION (Mesquite Foyer)
8:15 - 8:30 am	Introduction--Edie Allen
8:30 - 9:20 am	Keynote - David Wardle(*Mesquite AB*)
9:20 - 10:10 am	Keynote - Patrick Bohlen (*Mesquite AB*)
10:10 - 10:30 am	*Morning break* (*Mesquite Foyer*)
10:30 am - 12:00 pm	Contributed Talks: Session A (*Mesquite AB*)
10:30 am - 12:00 pm	Contributed Talks: Session B (*Mesquite DE*)
12:00 - 1:15 pm	*Lunch (pre-paid with registration) (Veranda)*
1:15 - 2:30 pm	Contributed Talks: Session A (*Mesquite AB*)
1:15 - 2:30 pm	Contributed Talks: Session B (*Mesquite DE*)
2:30 - 2:45 pm	*Afternoon Break* (*Mesquite Foyer*)
2:45 - 4:15 pm	Contributed Talks (one session) (*Mesquite AB*)
4:30 - 7:00 pm	*Poster Session & Mixer (snacks and no-host bar) (Mesquite C)*
	Supper on your own

Tuesday, May 13

8:00 am - 4:30 pm	REGISTRATION (Mesquite Foyer)
8:30 - 9:20 am	Keynote - Mary Firestone and Christine Hawkes(*Mesquite AB*)
9:20 - 10:10 am	Keynote - David Rizzo(*Mesquite AB*)
10:10 - 10:30 am	*Morning Break (Mesquite Foyer)*
10:30 am - 12:00 pm	Contributed Talks (*Mesquite AB*)
12:00 - 1:15 pm	*Lunch (pre-paid with registration) (Veranda)*
1:15-2:45pm	Contributed Talks (*Mesquite AB*)
2:45 - 3:00 pm	*Afternoon Break (Mesquite Foyer)*
3:00 - 4:15 pm	Contributed Talks (*Mesquite AB*)
4:30 - 5:30 pm	SES Business Meeting (open to all) (*Mesquite AB*)
6:00 - 6:30 pm	*Mixer (no host bar)*
6:30 TO ??	*Awards Barbeque (purchased tickets required) (Pool Deck)*

Wednesday, May 14

8:30 - 9:30 am	Contributed Talks (*Mesquite AB*)
9:30 - 9:45 am	*Morning Break* (*Mesquite Foyer*)
9:45 - 10:45am	Contributed Talks
11:30 am - 6:00 pm	*Depart for Joshua Tree National Park field trip (purchased tickets required)*

DETAILED SCHEDULE AND ORAL PRESENTATIONS

SUNDAY, MAY 11

1:00-7:00 pm *Lobby by Vista Room*	REGISTRATION
4:30 – 6:00 pm *Vista Room*	Mixer (snacks and no-host bar)
6:00 - 6:45 pm *Mesquite AB*	Introductory Speaker – Mike Allen "Habitat Conservation Planning, Invasive Species, and Soil Ecology Issues in the Coachella Valley"
	Supper on your own

MONDAY, MAY 12

8:15-8:30	Introduction--Edie Allen
8:30-10:10 am *Mesquite AB*	**Keynote Speakers** Edie Allen, presiding
8:30 –9:20 am	David Wardle "Belowground Consequences of Introduced Browsing Mammals in New Zealand Rainforest"
9:20 – 10:10 am	Patrick Bohlen "Invasive Earthworms and Their Impacts on Soil Functioning"
10:10 – 10:30 am *Mesquite Foyer*	*Morning break*
10:30am-12:00pm *Mesquite AB*	**Contributed Talks: Session A** Jay Gulledge, presiding
	TRACE GASES:
10:30	Six, J., S.M. Ogle, F.J. Breidt, R.T. Conant, A.R. Mosier and K. Paustian. Greenhouse Gas Mitigation through No-till: The Rest of the Story.
10:45	Gulledge, J., J. Baoming , A. Poret-Peterson, and E. Engelhaupt. Temperature and Moisture Controls on CO_2 and CH_4 Fluxes in a Coastal Wetland Forest Soil Experiencing Rapid Relative Sea Level Rise
	ECOTOXICOLOGY:
11:00	Lanno, R.P. and L.S. McCarty. Issues at the Interface between Soil Ecology and Ecotoxicology.
	CRYPTOBIOTIC CRUSTS:
11:15	Housman, D., and J. Belnap. Photosynthetic Performance of Biological Soil Crusts under Contrasting Temperature and Precipitation Regimes.
11:30	Bamforth, S.S. Brigadoon in the Desert: Water Film Fauna in Desert Crust Soils.
12:00 – 1:15 pm *Veranda*	*Lunch (pre-paid with registration)*

10:30am-12:00pm *Mesquite DE*	**Contributed Talks: Session B** Matthias Rillig, presiding
	MYCORRHIZAE:
10:30 am	Trofymow, J.A., and R. Outerbridge. Keeping All the Pieces: Ectomycorrhizal Fungal Diversity and Forest Harvest Practices.
10:45 am	Moser, A.M., C.A. Petersen, H. Tugaw, H.K. Berninghausen, D. Southworth. Oak Mycorrhizae on Serpentine Soils.
11:00 am	Rillig, M.C., E.R. Lutgen, P.R. Ramsey, D. Muir-Clairmont, L.J. Lamit, and S.J. Morris. The Arbuscular Mycorrhizal Fungal Protein Glomalin: Spatial and Temporal Patterns.
11:15 am	He, X., W.R. Horwath, C.S. Bledsoe, R.J. Zasoski, and I.W. Travis. Belowground Transfer of Nitrogen among Plants in a California Oak Woodland.
11:30 am	Bornyasz, M.A., R.C. Graham, and M.F. Allen. Rock-sipping Fungi: Key to Evergreen Tree Survival in a Mediterranean Climate.
11:45 am	Besmer, Y.L., R.T. Koide, and S.J. Twomlow. Ecology and Function of Arbuscular Mycorrhizal Fungi (AMF) in Subsistence Agriculture in the Semi-Arid Tropics – A Comparison with Temperate Mesic Agroecosystems.
12:00 – 1:15 pm *Veranda*	*Lunch (pre-paid with registration)*
1:15-2:30pm *Mesquite AB*	**Contributed Talks: Session A** Ralph Boerner, presiding
	RESTORATION:
1:15 pm	Hart, S.C., S. I. Boyle, J. P. Kaye, D. R. Guido and J. Thomas. Long-Term Effects of Restoration on the Soil Ecology of a Ponderosa Pine - Bunchgrass Ecosystem.
1:30 pm	Boerner, R.E.J., T.A.Waldrop, J.A. Brinkman, and M.A. Callaham, Jr. Structural and Functional Restoration Effects on Soil Microbial Activity in Two Contrasting Forest Ecosystems.
1:45 pm	Stahl, P.D., J.D. Anderson, L.J. Ingram, and G.E. Schuman. Relationship between Soil Organic Carbon and Microbial Biomass in Reclaimed and Undisturbed Soils in Wyoming, USA.
	SPATIAL DISTRIBUTION:
2:00 pm	Madson, S. L., and D. C. Coleman Finding Common Ground: Microhabitats as a Compatible Spatial Scale between Soil Microarthropod Communities and Harvested Forest Stands in the Southern Appalachians.
2:15 pm	Killgore, A.J., and W.G. Whitford. Spatial and Temporal Characteristics of Biopedturbation on a Semi-Arid Rangeland: Effects on Soil Quality and Seedling Recruitment.
1:15-2:30 pm *Mesquite DE*	**Contributed Talks: Session B** Yossi Steinberger, presiding
	MYCORRHIZAE (continued):
1:15 pm	Swenson, W., and M.F. Allen. Employing Ecological Stoichiometry to Model Complexity in Communities of Mycorrhizal Fungi and Plants.

SOIL ORGANIC MATTER, DECOMPOSITION:

1:30 pm	Simpson, R.T., S.D. Frey, and J. Six. Location of Bacterial- and Fungal-Derived Organic Matter within the Soil Aggregate Structure.
1:45 pm	Kaffe-Abramovich, T., and Y. Steinberger. The Effect of Soil Biota on the Rate of *Zygophyllum dumosum* Leaf Weight Loss in a Desert Soil Ecosystem.
2:00 pm	Grandy, A.S. and G.P. Robertson. Soil Carbon, Nitrous Oxide, and Aggregation Changes Immediately Following Cultivation of an Undisturbed Soil Profile.
2:15 pm	Fierer, N., J.P. Schimel, and P.A. Holden. The Relationship Between Microbial Community Structure and C Dynamics in a Soil Profile.
2:30-2:45 pm *Mesquite Foyer*	*Afternoon Break*
<u>2:45-4:15pm</u> *Mesquite AB*	**<u>Contributed Talks (one session)</u>** Bob Sinsabaugh, presiding

NITROGEN DEPOSITION, C AND N DYNAMICS:

2:45 pm	Cheng, W. Roots Affect Turnover Rates of Soil Carbon and Nitrogen.
3:00 pm	Liptzin, D., and T.R. Seastedt. The Effect of Trees on Soil Carbon and Nitrogen in the Forest-Tundra Ecotone, Niwot Ridge, Colorado.
3:15 pm	Leckie, S.E., C.E. Prescott, S.J. Grayston, J.D. Neufeld, and W.W. Mohn. Soil Microbial Communities in Forests That Differ in Nitrogen Availability.
3:30 pm	Sinsabaugh, R.L., D.R. Zak, M. Waldrop, and M.E. Gallo. N Deposition, Microbial Community Organization and Soil Carbon Dynamics in North Temperate Forests.
3:45 pm	Holland, K.J., A.R. Townsend, C. Ordoyne, B.C. Constance, and W.D. Bowman. The Effect of Nitrogen Availability on Soil Enzyme Activities in Alpine Tundra.
4:00 pm	Weintraub, M.N. and J.P. Schimel. Soil Amino Acid Dynamics in the Arctic Tundra of Alaska.
<u>4:30 – 7:00pm</u> *Mesquite C*	**<u>Poster Session & Mixer</u>** (snacks and no-host bar)

Supper on your own

TUESDAY, MAY 13

8:30 – 10:10 am **<u>Keynote Speakers</u>**
Mesquite AB Josh Schimel, presiding

8:30 – 9:20 am Mary Firestone and Christine Hawkes "Impacts of Invasive Species on Root-associated Microorganisms and N-cycling in Grasslands"

9:20 – 10:10 am David Rizzo "The Soil-Borne Fungus *Phytophthora ramorum* and Sudden Oak Death"

10:10 – 10:30 am *Morning Break*
Mesquite Foyer

<u>10:30am–12:00pm</u> **<u>Contributed Talks</u>**
Mesquite AB Diana Wall, presiding

INVASIVE SPECIES IMPACTS:

10:30 am Zhu, W.X., and S.S. Fickbohm. Purple Loosestrife (*Lythrum salicaria)* Invasion of Cattail (*Typha latifolia*) Freshwaer Wetlands: Changes beyond Aboveground Species Replacement.

10:45 am Yelenik, S.G., W.D. Stock, and D.M. Richardson. Ecosystem-Level Impacts and Restoration Implications of Invasive *Acacia Saligna* in the South African Fynbos.

11:00 am Bastow, J.B., E.L. Preisser, and D.R. Strong. The Effect of an Invasive Grass, *Holcus lanatus*, on the Breakdown of Litter by *Porcellio scaber*.

11:15 am St. John, M., D. Wall, and V. Behan-Pelletier. Effects of an Invasive Grass on the Community of Associated Soil Mites in a Tallgrass Prairie.

11:30 am Batten, K.M., K.M. Scow, and S.P. Harrison. Plant Invasions and Soil Microbial Communities in Serpentine Soils.

11:45 am Classen, A.T., J. DeMarco, and S.C. Hart. Chronic Insect Herbivory Alters Microbial Biomass, Litter Microarthropods and Community Level Physiological Profiles in a Semi-Arid Woodland.

12:00 –1:15 pm *Lunch (pre-paid with registration)*
Veranda

<u>1:15-2:45pm</u> **<u>Contributed Talks</u>**
Mesquite AB Walt Whitford, presiding

INVASIVE SPECIES IMPACTS (continued):

1:15 pm Reed, H.R., and T.R. Seastedt. When a C4 Grass Species Invades a C4 Grassland, Does It Change Soil Processes? Case Of *Andropogon bladhii* vs. *Andropogon gerardii.*

1:30 pm Meiman, P.J., E.F. Redente, and M.W. Paschke. The Role of the Soil Community in the Invasion Ecology of Two Exotic Knapweeds.

1:45 pm Byrne, L.B., M.A. Bruns, and K.C. Kim. The Effects of Lawn Management on Soil Arthropods.

2:00 pm	Pett-Ridge, J., W.L. Silver, and M.K. Firestone. The Effects of Oxic/Anoxic Fluctuation on Microbial Communities and Nitrogen Cycling in a Wet Tropical Soil.
	MICROFAUNA/FLORA PROCESSES AND RESPONSES:
2:15 pm	Preisser, E.L., and D.R. Strong. Biotic and Abiotic Control of an Underground Trophic Cascade.
2:30 pm	Taylor, H.S., W. P. Mackay, and W. G. Whitford Impact of Environmental Stressors on Soil Mite Populations in Northern Chihuahuan Desert Grasslands.
2:45-3:00 pm *Mesquite Foyer*	*Afternoon Break*
3:00-4:15 pm *Mesquite AB*	**Contributed Talks** Clive Edwards, presiding
	MICROFAUNA/FLORA PROCESSES AND RESPONSES (continued):
3:00 pm	Adl, S.M., D.C. Coleman, and M. Hunter. Protozoan Activity in Leaf Litter Decomposition.
3:15 pm	Pen-Mouratov, S. and Y. Steinberger. Pesticides Effect on Soil Free Living Nematode Community Structure and Diversity.
3:30 pm	Edwards, C. A., and N. Q. Arancon. Effects of Vermicomposts on Plant Disease, Plant Parasitic Nematodes and Arthropod Pest Incidence.
3:45 pm	Arancon, N.Q., C. A. Edwards, S. Lee, and R. Atiyeh. Effects of Humic Acids and Aqueous Extracts Derived from Vermicomposts on Plant Growth.
4:00 pm	Drenovsky, R.E., and K.M. Scow. Microbial Community Composition along a Desert Dune Chronosequence.
4:30 – 5:30 pm *Mesquite AB*	**SES Business Meeting** (open to all)
6:00 – 6:30 pm	**Mixer** (no host bar)
6:30 TO ?? *Pool Deck*	**Awards Barbeque** (purchased tickets required)

WEDNESDAY, MAY 14

8:30 - 11:00am *Mesquite AB*	**Contributed Talks** Jayne Belnap, presiding **INVASIVE SPECIES IMPACTS:**
8:30 am	Heneghan, L., F. Fatemi, B. Bernau, C. Rauschenberg, K. Fagen, and M.A. Workman. The Impact of an Invasive Shrub (*Rhamnus cathartica* L.) on Soil Foodwebs and Some Ecosystem Properties in Urban Woodland in Chicago, Illinois, and The Potential Implications for Management.
8:45 am	Hendrix, P.F. Biological Invasions Belowground: Interactive Effects of Native and Exotic Earthworms on Soil Processes.
9:00 am	Winsome, T., L. Epstein, P.F. Hendrix, and W.R. Horwath. Predicting The Relative Abundance of Exotic and Native Earthworm Species Following Land Use Change in California Oak Savanna.
9:15 am	Szlavecz, K. and E. Hornung. Population Characteristics and Reproductive Strategies of Introduced Terrestrial Isopods: A Comparison between North American and European Populations.
9:30-9:45 am *Mesquite Foyer*	*Morning Break*
9:45 -10:45am	**Contributed Talks** **INVASIVE SPECIES IMPACTS (continued):**
9:45 am	Kaneko, N. Linking The Periodical Millepede to Plant Growth Periodicity.
10:00 am	Corbin, J.D., and C.M. D'Antonio. Nitrogen Retention and Loss in Native- and Exotic-Dominated California Coastal Prairie Grasslands.
10:15 am	Wood, Y.A., and T. Meixner. Hydrologic Controls on Soil Nitrogen Concentrations of Southern California Coastal Sage Scrub across an Air Pollution Gradient.
10:30 am	Belnap, J., and S.L. Phillips. *Bromus tectorum* Attacks!! The Response of Soil Biota in a Never-Grazed Semi-Arid Grassland.
11:30am–6:00 pm	**Depart for Joshua Tree National Park field trip** (purchased tickets required)

POSTER PRESENTATIONS

IMPACTS OF INVASIVE/EXOTIC PLANTS AND MESOFAUNA:

1. Blakemore, R. J. **Cosmopolitan earthworms – an eco-taxonomic guide to the peregrine species of the world.**

2. Caldwell, B.A. **Effects of invasive scotch broom on microbial activity in a coastal prairie soil.**

3. Callaham, M.A., Jr., C.D. Babb, M.A. Williams, P.F. Hendrix and M.L. Cabrera. **Effects of native North American and introduced exotic earthworms on denitrification rates in two soils.**

4. Cheng X. and C. Bledsoe **Effects of annual grass senescence on $^{15}NH_4^+$ and ^{15}N-glycine uptake by blue oak (*Quercus douglasii*) seedlings, and soil microbes in California oak woodland.**

5. Migge, S., D. Parkinson and S. Scheu. **Earthworm invasion of Canadian aspen forest soils: impact on soil microarthropod communities.**

6. Parker S.S. and J.P. Schimel**. Nitrogen transformations in native perennial and exotic annual grasslands in California.**

7. Resinger, J.S., J. Sirotnak, and J.C. Zak. **Microbial and Soil Nutrient Dynamics Associated With Degraded Grasslands in Big Bend National Park.**

8. Ross, K.A. and J.G. Ehrenfeld. **Effects of nitrogen supply on the dynamics and control of Japanese barberry (*Berberis thunbergii*) and Japanese stiltgrass (*Microstegium vimineum*).**

9. Smith, M.D., G.W.T. Wilson and C.W. Rice. **Effects of dominant grass removal on microbial community structure and function in tallgrass prairie soil.**

10. Thorpe, A.S. and R.M. Callaway. **Interactions between *Centaurea maculosa* Lam. and the soil nitrogen cycle.**

11. Winters, M. and D. Lipson. **The Effects of an Invasive Plant Community on the Coastal Sage Scrub Soil Microbial Community.**

12. Zimman, A.M. and P.J. Bohlen. **Impacts of sod harvesting on organic matter and microbial activity in subtropical pastures.**

AUTECOLOGY/ PHYSIOLOGY/ STRUCTURE-FUNCTION:

13. Sampedro, L., and J.K. Whalen. **Are differences in biological activity between soil and earthworm casts related to the size of soil particles consumed by earthworms?**

14. Sampedro, L., J.K. Whalen, B. Shanmugam and T. Waheed. **Changes in soil microbial community structure during transit through the earthworm gut.**

15. Selby, G., P. Saunders, M. K. Chelius, and J. C. Moore. **Notes on the distribution and life history of Arrhopalites caecus (Tullberg) in Wind Cave, South Dakota.**

16. E. A. Sobek and J. C. Zak. **The Functional Capacity Of Desert Soil Fungi: From Landscape To Locale To Site.**

17. R. K. Thiet, S. D. Frey, and J. Six. **Examining fungal vs. bacterial growth yield efficiencies: does the myth hold up?**

18. Toyota, A., N. Kaneko and M.T. Ito. **Control of nutrient mineralization by the the periodical train millipede, *Parafontaria laminata* (Diplopoda: Xystodesmidae) on larch forest soil in Central Japan.**

19. Waheed, T., J.K. Whalen and L. Sampedro. **Quantifying surface and subsurface cast production by *Aporrectodea rosea* (Savigny) and *Lumbricus terrestris* L. under controlled conditions.**

20. Winsome, T. , L. Epstein, P. F. Hendrix and W. R. Horwath. **Habitat quality and interspecific competition between native and exotic earthworm species in a California grassland.**

IMPACTS OF TOXINS AND PESTICIDES:

21. Edwards, C.A. and L. Burrows. **Earthworms as test organisms in the ecotoxicological assessment of the impact of pollutants on soil ecosystems.**

22. Kuperman, R.G., M. Simini, C.T. Phillips, R.T. Checkai, J.E. Kolakowski, C.W. Kurnas and G.I. Sunahara. **Soil invertebrate-based ecological soil screening levels (Eco-SSL) for explosive contaminants in soil.**

23. Morris, B., C. Green, M. San Francisco, R. Zartman and J. Zak. **Impacts of Ricin on soil microbial activity.**

24. Quirk, M., J. King, D. Milchunas, A. Mosier, C. Pritekel and J. Moore. **Initial impacts of altered UVB radiation on below ground food web interactions in shortgrass steppe.**

25. Ojalvo-Mayzlish, E. and Steinberger, Y. **Effects of inhibitors on the dynamics of the protozoa population in a desert soil ecosystem.**

26. Pritekel, C. M., A. A. Whittemore-Olson, H. Fenstemaker, S. Montano, T. Rivas, N. Snow and J. C. Moore. **Impacts from the use of herbicides on the plant community and below ground ecosystem at Rocky Mountain National Park, USA.**

27. Zaborski, E. R. **Earthworms, soil mites and litter decomposition as influenced by insecticide application and three years of Bt transgenic corn production.**

MYCORRHIZAE:

28. Cheng X. and K. Baumgartner. **Root system distribution and arbuscular mycorrhizal colonization of grapevines in a California vineyard.**

29. Corkidi, L., E.B. Allen, D. Merhaut, M.F. Allen, J. Downer, J., Bohn and M. Evans. **Assessing the infectivity of commercial mycorrhizal inoculants in plant nursery conditions.**

30. Meding, S.M., R.J. Zasoski and D.E. Beaudette. **Transfer of ^{15}nitrate and rare element analogs of phosphorous, potassium, and calcium through common mycorrhizal networks for grass and forb species of the Sierra foothills of California.**

31. Oba, H. , N. Shinozaki, H. Oyaizu, K. Tawaraya, T. Wagatsuma, W. L. Barraquio and M. Saito. **Arbuscular mycorrhizal fungal flora associated with some pioneer plants in lahar area of Mt. Pinatubo, Philippines.**

32. Sawahata, T. and M. Narimatsu . **Influence of colonization by ectomycorrhizal fungi, *Tricholoma matsutake* on vertical distribution and abundance of mycophagous soil fauna.**

33. Querejeta, I., L. Egerton-Warburton, A. Lindahl, and M.F. Allen. **Differential access to groundwater and hydraulic lift determine tree mycorrhizal status during prolonged drought in a southern California oak woodland.**

FOOD WEBS:

34. Cabrera, A. R., E.R. Zaborski and R. A. Cloyd. **Development and reproduction of *Hypoaspis miles* (Mesostigmata: Laelapidae) with fungus gnats, *Bradysia ocellaris* (Diptera: Sciaridae), potworms (Oligochaeta: Enchytraeidae) and *Sancassania* sp. (Acari: Astigmata) as prey.**

markers for gram-negative bacteria. Further, the ratio of cyclopropyl fatty acids to their precursors was considerably lower in prairie than in agricultural plots indicating higher substrate availability in the restored prairie soils. Regression of ordination plots against environmental variables indicated that the chronosequence represents an aggrading soil system, with microbial composition related to a suite of environmental variables, most notably increased production of root biomass, surface litter accumulation, and a widening of plant tissue and soil C:N ratios. These changes in biotic and edaphic factors encountered along the chronosequence appear to be related to the termination of tillage and fertilizer inputs, and especially to the associated increases in plant biomass (both above and belowground), all associated with the cessation of agriculture.

ARANCON, N.Q., EDWARDS, C.A., LEE, S., and ATIYEH, R. Effects of humic acids and aqueous extracts derived from vermicomposts on plant growth. Soil Ecology Laboratory, The Ohio State University, Columbus, OH.

Vermicomposting is the biological degradation and stabilization of organic wastes by earthworms. Vermicomposts from animal manure, sewage sludge, or paper-mill sludge have high levels of humic substances, which have been reported to induce positive plant growth responses at lower concentrations, but decreasing plant growth at higher concentrations. The stimulatory effect of humic acids may be a direct, hormonal action on the plants.

The objectives of our experiments were: to determine the effects of a range of concentrations of vermicompost-derived humic acids on tomato and cucumber growth; and to investigate the effect of humic acids and aqueous extracts from vermicomposts on the growth of marigold, pepper, and strawberry seedlings.

In the first experiment, humic acids were extracted from pig vermicompost and mixed with a soilless container medium (Metro-Mix 360) to provide a range of 0-4000 mg of humates per kg of dry weight of MM360, and tomato seedlings were grown in the mixtures. Humates extracted from pig and food vermicomposts were mixed with vermiculite to provide a similar range, and cucumber seedlings were grown in the mixtures. Humates from food waste vermicomposts were mixed with Metro-Mix 360 to provide a similar range, and marigolds were grown in the mixtures. Tomato, cucumber and marigold seedlings received a daily solution containing all required nutrients so that the growth responses were not nutrient-mediated. All humic acid extracts applied to either type of plant growth media increased the growth of tomato and cucumber plants significantly, in terms of plant heights, leaf areas, shoot and root dry weights. Plant growth tended to increase after treatments of the plants with 50-500 mg/kg humic acids, but decreased at concentrations above 500-1000 mg/kg. These growth responses were probably due to a hormone-like activity of humic acids from the vermicomposts or could have been due to plant growth regulators adsorbed onto the humates.

In another experiment, aqueous extracts from samples of cattle, food, and paper waste-based vermicomposts were applied daily to marigold, pepper and strawberry seedlings at 10% and 20% volume, with the solutions balanced for nitrogen content. Humic acids extracted from cattle, food and paper waste-based vermicomposts were applied to other pots before seeding at concentrations of 250 and 500 mg/kg. After 21 days, seedlings were harvested and plant height, leaf area, and root and shoot biomass measured. For all plants, 10% cattle waste aqueous extract did not increase yields significantly above the controls, but 20% did. Food waste and paper waste aqueous extracts at 10%, but not 20%, increased plant growth significantly above controls, suggesting that food waste and paper waste aqueous extracts are more potent than that of cattle waste. The humic acids had the same trend as the aqueous extracts for the root dry mass of all plants, with much higher increases in humic acid-substituted plants, indicating a similar but more potent action of humic acids on the roots than aqueous extracts.

The increased plant growth may be due to plant growth hormones being adsorbed onto the humic acids and act in conjunction with them to enhance shoot and root growth.

ARANCON, N.Q., EDWARDS, C.A, BIERMAN, P., METZGER, J., LEE, S., and WELCH, C. Effects of vermicomposts on growth and yield of field crops. Soil Ecology Laboratory, The Ohio State University, OH.

Vermicomposts are products of a non-thermophilic biodegradation and stabilization of organic materials by interaction between earthworms and microorganisms. The humus-like products have excellent physiochemical and biological properties and make-up good organic soil conditioners. However, vermicompost applications have been very limited in commercial crop production because of a lack of extensive investigations in a wide range of field crops and climatic conditions. Our main aim was to investigate the effects of vermicompost applications on the growth and yield of tomatoes, peppers and strawberries. Vermicomposts produced commercially from cattle manure, food waste and recycled paper were applied to field plots planted with tomatoes (*Lycopersicon esculentum*) and bell pepper *(Capsicum anuum grossum)* at rates of 20 t/ha and 10 t/ha in 1999 and at rates of 10 t/ha and 5 t/ha in 2000. Food waste and recycled paper vermicomposts were applied at the rates of 10 t/ha and 5 t/ha in 2000 to plots planted with strawberries (*Fragaria spp.*). Control plots were treated with inorganic fertilizers only and all of the vermicompost-treated plots were supplemented with inorganic fertilizers to equalize the available N levels in all plots at transplanting.

The marketable tomato yields in the vermicompost-treated plots were consistently greater although they did not differ statistically from the yields in the inorganic treated plots The amounts of total N, orthophosphates, dehydrogenase enzyme activity, and the microbial biomass were greater in the soils from vermicompost plots but only on certain sampling dates. There were significant increases in shoot weights, leaf areas and marketable fruit yields in pepper plants from plots that were treated with vermicomposts compared to those from the inorganic control plants. There was more microbial biomass N and orthophosphates in soils that were treated with vermicomposts than in the inorganic controls. There were no significant differences in yields between application rates of 10 t/ha and 5 t/ha. Leaf areas, numbers of strawberry suckers, numbers of flowers, shoot weights, and marketable fruit yields increased significantly in plants that received vermicompost treatments compared to those from strawberries that received inorganic fertilizers only. Food waste vermicomposts had greater effects on the growth and yields of strawberries than paper waste vermicomposts. The total extractable N, microbial biomass N and dissolved organic N were statistically similar among all treatments at end of the growth cycle of strawberries. There were more orthophosphates in soils that received vermicompost treatments than in the inorganic control plots.

The improvements in plant growth and increases in yields could not be explained by the availability of macronutrients because all vermicompost treatments were supplemented with inorganic fertilizers to equalize macronutrient availability at transplanting time. Based on other research in our laboratory we consider that the increases in growth and yields may have been due to production of plant growth regulators or to the effects of humates in the vermicomposts since these can produce growth effects independent of nutrients.

BAER, S.G.[1] and BLAIR, J.M[2]. Soil C affects N availability in newly restored prairie: implications for restoration of plant diversity. [1]Southern Illinois University, Carbondale, IL, and [2]Kansas State University, Manhattan, KS.

Prairie restorations often occur in formerly cultivated soils that exhibit higher levels of nitrogen (N) availability and lower levels of carbon (C) than native prairie. We altered soil C and N levels in a prairie restoration to test hypotheses related to the role of nutrient availability and heterogeneity in restoring floristic diversity. Three N availability treatments of reduced-N, ambient-N, and enriched-N were randomly assigned to four plots in a strip-plot design. Prior to the restoration, a pulse amendment of C (sawdust) was incorporated into the surface 15-cm of the soil to reduce N availability. Soil assigned to the enriched-N treatment was fertilized annually with ammonium-nitrate. We measured total C and mineralizable C pools in the surface 5-cm of soil at the emergence in the youngest block, but not in the older two. Thinning resulted in reduced chitinase activity in the oldest block. Phenol oxidase activity was reduced by both burning and thinning in the oldest block. Multiple regression indicated that post-treatment enzyme activity in this pine-dominated ecosystem was most closely linked to pretreatment soil carbon content and post-treatment soil C:N ratio. In the oak-hickory ecosystem, acid phosphatase activity was reduced by burning in all three blocks, whereas chitinase activity was unaffected. Phenol oxidase activity was increased by fire in the most fertile block. Thinning reduced acid phosphatase activity, but only in the least fertile block. Multiple regression indicated that post-treatment enzyme activity in the hardwood-dominated ecosystem was most closely linked to post-treatment soil carbon content, and to a lesser extent post-treatment soil C:N ratio, soil moisture, and soil texture. These preliminary results suggest that the consequences of restoration treatments on soil microbial activity may vary within and among ecosystem types in relation to their effects on the quality and quantity of soil organic matter.

BRINKMAN, J.A., BOERNER, R.E.J., AND SMITH, A. Effects of Forest Ecosystem Restoration Treatments on Soil Chemical and Biochemical Properties. Ohio State University, Columbus, OH.

Structural restoration based on thinning from below to pretreatment tree density and basal area, functional restoration based on reintroduction of dormant season fire and a combination of the two were each applied to forested areas of 15-30 ha each in three study sites within the oak-hickory (*Quercus-Carya*) region of southern Ohio. Soils sampled from permanent sampling plots were taken in the summers of 2000 (prior to treatment) and 2001 (after winter thinning and spring burning). Nonmetric multidimensional scaling (NMS) of 26 soil chemical and biochemical parameters in pre- and post-treatment samples revealed two major gradients of variation: one which described differences among the three study sites and one which was based on the differences between pre- and post-treatment years. The separation along this second gradient appeared generally similar in the untreated controls and in the various treatment plots, suggesting that actual treatment effects were somewhat confounded by year-to-year variation. Analysis of variance confirmed the importance of among-sites and between-years variance components, and also revealed significant effects of fire on N mineralization rate and acid phosphatase activity. Thinning affected available Al and phenol oxidase activity, and the combination of thinning and burning affected soil [C], soil [N], and N mineralization rate. Ordinations such as NMS that are tailored to data with log normal distributions (as is the case with many soil properties) can reveal subtle shifts in soil conditions which may be ecologically meaningful.

ɔwms ↑ microbial biomass in mineral soil ↑ CC (↑ in resp.) diff in mineralization

BOHLEN, P.J. Ecosystem consequences of invasion of northern forest by exotic earthworms. Archbold Biological Station, Lake Placid, FL.

Invasion by exotic species has emerged as a major topic in ecology over the past 20 years but most invasion studies have focused on changes in aboveground plant and animal communities, with much less work on invasions of the soil community. Invasion studies have focused on biodiversity or species changes and the effects of invasion on ecosystem processes and nutrient cycling and loss are less well studied. Earthworm invasions represent a unique opportunity to assess changes in ecosystem processes that accompany invasions by exotic species. Such invasions are likely to have the greatest impact on ecosystem processes when exotic earthworm species invade ecosystems previously devoid of earthworms. Alternatively, earthworm invasions may alter ecosystem processes when the invading species differs substantially from native species in some significant aspect of behavior or life history. My colleagues and I initiated research to address the hypothesis that earthworm invasion of north temperate forests would have large consequences for nutrient retention and uptake in these ecosystems. The most dramatic effect of earthworm invasion was the loss of the forest floor at an undisturbed forest site, which altered the location and nature of nutrient

Invasion by EW reduces total Soil C storage
– increase in uppermost Soil layer
EW don't influence N storage

C:N ratio increases in litter layer because EW use better quality cycling activity in the soil profile. Earthworm invasion decreased total soil C pools and altered soil P pools, but had less effect on total soil N. These changes were linked to decreases in soil C:N ratios, the redistribution of different soil P fractions and alteration in the distribution and function of roots and microbes. Response to invasion varied with site characteristics and earthworm species, indicating that both previous land use history and specific traits of invading species will be important in determining the response of forest nutrient cycles to earthworm invasion. Our results suggest that exotic earthworm invasion is a significant factor that will influence the structure and function of northern temperate forest ecosystems over the next few decades. Invasion of north temperate forests is presented as a specific example of the more general case of earthworm invasions in terrestrial ecosystems.

BORNYASZ, M.A.[1,2], GRAHAM, R.C.[1], and ALLEN, M.F.[2] Rock-sipping fungi: Key to evergreen tree survival in a Mediterranean climate. [1]Soil and Water Sciences Program, Department of Environmental Sciences, and [2]Center for Conservation Biology, University of California Riverside, CA.

The spatial distribution of mycorrhizae and hyphae in a regolith of thin soils overlying weathered granitic bedrock has been investigated at Santa Margarita Ecological Reserve in southern California. Formation of mycorrhizae in weathered bedrock fractures, and extension of hyphae from the fractures into the matrix, is thought to be a potential mechanism by which the fracture-confined roots access rock-matrix water, stored in micropores, that is otherwise unavailable to plants. The regolith, studied in a 4-m deep by 15-m long exposure, consisted of thin soils (24-100 cm thick) overlying four variations in parent materials (granodiorite, tonalite, monzogranite, and quartz diorite with incorporated gabbro), and a fault gouge. Mid-growing season, plant available water was depleted from the soil and was most abundant in the weathered bedrock matrix between 1 m and 1.75 m depth (0.06 m^3 water/m^3 material). By October, plant available water was depleted from matrix materials to depths of 300 m. Spatial patterning and chemical conditions of fractures varied between parent materials, but ectomycorrhizal root tips were found throughout the regolith to depths of 4 meters. Some infection frequencies of fracture-confined roots (ranged from 1-63%) were similar to those found in the upper 30 cm of soil (ranged from 33-94%). Total N was extremely low in the fractures and negligible in the matrix materials; therefore we assume that N deficits are not driving the patterns of ectomycorrhizal infection and hyphal distribution in the sub-soil portion of the regolith. We presume that water uptake is the function of the deep mycorrhizae in the regolith, and propose that the formation of mycorrhizae in weathered bedrock fractures, and hyphal extension into the matrix, may be crucial to the water balance of evergreen trees in Mediterranean climates by providing a link between bedrock matrix resources and the plant.

BROOKS, M. and LAIR, B. Potential effects of atmospheric nitrogen deposition on the dominance of alien annual plants in the Mojave Desert. United States Geological Survey, Western Ecological Research Center, Las Vegas Field Station, Henderson, NV.

Deserts are one of the least invaded ecosystems, possibly due to naturally low levels of soil nitrogen. Increased levels of soil nitrogen caused by atmospheric nitrogen deposition may increase the dominance of invasive alien plants and decrease the diversity of plant communities in desert regions, as it has in other ecosystems. Deserts should be particularly susceptible to these changes, because even small nitrogen deposition rates translate into relatively large percent increases in available soil nitrogen. The hypothesis that increased soil nitrogen will lead to increased dominance by alien plants and decreased plant species diversity was tested in field experiments in the Mojave Desert. Nitrogen applied at rates similar to those measured in urban areas adjacent to the Mojave Desert (3.2 g $N/m^2/yr$), increased the density and biomass of alien annual plants during two years of contrasting annual plant productivity. During the high productivity year, nitrogen additions also led to decreased denitrification than soil with *Diplocardia* spp. or control soils after 10 days (5.1 vs. 0.8 and 0.05 ng N_2O-N $g^{-1}h^{-1}$, respectively) . This effect was not observed at 20 days, but reappeared at the 30 day sampling. *Aporrectodea* exhibited a strong positive influence on total respiration in microcosms after 10 days, but this effect was not observed at 20 or 30 days. There were no significant earthworm effects on specific activity of denitrification enzyme in the microcosms. In the second experiment we compared *Diplocardia* spp. and *Amynthas* spp. in soils collected from the Coweeta Hydrologic Laboratory in North Carolina. We again compared effects of each species on denitrification and total respiration rates, as well as soil NO_3 and NH_4 concentrations and total extractable organic C concentrations. Results from this second experiment will also be presented and discussed.

CALLAHAM, M.A., JR.[1], RICHTER, D.D.[2], COLEMAN, D.C.[3], HOFMOCKEL, M.[2], and COLLANTES, H.[3] **Effects of long-term land use on organization and complexity of soil invertebrate communities in South Carolina Piedmont soils.** **[1]USDA Forest Service, Southern Research Station, Athens, GA, [2]Duke University, Nicholas School of the Environment and Earth Sciences, Durham, NC, and [3]University of Georgia, Institute of Ecology, Athens, GA.**
Historically, a large percentage of land area in the Piedmont of South Carolina was under intensive agricultural management for the production of cotton. This intensive farming resulted in massive losses of topsoil, and general degradation of soil resources in the region until insect pests and bad economic conditions forced large-scale abandonment of farmland around the 1930s. In subsequent decades, there have been four predominant land-use trajectories in the region and these include 1) continued row-crop cultivation, 2) conversion to grass for pasture or hay production, 3) establishment of loblolly or shortleaf pine plantations, and 4) maintenance or regeneration of the native oak and hickory hardwood forests. As part of a larger study examining the influence of these different land uses on biological complexity within soils, we sampled earthworms, macroarthropods and microarthropods from 3 replicated cultivated fields, pastures, loblolly pine stands, and remnant hardwood stands. In addition to abundance and biomass data for all invertebrate taxa collected, we calculated community indices including diversity, richness, evenness and percent similarity in an attempt to identify patterns of community assemblage within each land use type. Preliminary results from this work suggest that soils in the remnant hardwood stands support the most taxonomically diverse macroinvertebrate communities followed by pine stands, pastures, and cultivated fields in order of decreasing diversity. Microarthropod diversity was observed to be highest in pine stands with decreasing diversity in hardwood stands, pastures and cultivated fields, respectively. Similarity between invertebrate communities was highest between hardwood stands and pine stands (49%), with cultivated fields and pastures being next most similar (36%). Cultivated fields and pine stands had the fewest taxa in common with a percent similarity of only 11%. A similar pattern was observed for microarthropods. These results indicate that relative levels of soil disturbance profoundly influence the community composition of soil invertebrates on the South Carolina Piedmont, and that more intense disturbance results in a less diverse community of invertebrates that is composed of taxa occurring exclusively or predominantly in disturbed habitats.

CAMPBELL, J.H., SOBEK, E.A., JETER, R.M, and ZAK, J.C. **Distributions of Oligotrophic Bacteria Along an Elevational Gradient at Big Bend National Park.** **Texas Tech University, Lubbock, TX.**
Bacteria which metabolize and divide at low concentrations of carbon are known as oligotrophs. Although distributions of oligotrophic bacteria in marine, freshwater and soil environments have been well documented, environmental parameters regulating these distributions have not been elucidated. Moreover, desert soils are commonly carbon limited, yet information pertaining to oligotroph distributions in desert ecosystems is scarce.

Currently, five sites representing both elevational and vegetational gradients are under study along the Pine Canyon Watershed at Big Bend National Park. Each site is composed of two transects along which soil pH, nitrate, ammonium, microbial biomass and organic matter have been measured during January and August of each year since 1996. Soil samples along each transect at each site are diluted, spread onto plates containing approximately 12 mg/L total carbon and incubated at 15°, 25°, 35°, 45° and 60°C.
Direct plate counts of bacterial morphologies have been compiled for both January and August 2002. Preliminary analysis of these counts indicates both site and incubation temperature differ significantly. Also, a significant interaction exists between site and temperature of incubation. Colony counts increased with elevation at 15°, 25° and 35°C, while counts were similar among sites at the 45°C incubation. No bacterial colonies were observed on plates incubated at 60°C. In order to determine environmental effects on oligotroph distribution, Canonical Correspondence Analysis of oligotroph morphologies in conjunction with site, incubation temperature and soil chemistry data will be performed.

BAL, A.[1], BERGE, O.[3], and CHANWAY, C.[1,2] **Can Endophytic Diazotrophs Supply Pine with Biologically Significant Amounts of Fixed Nitrogen?** **[1]Faculty of Forestry, [2]Faculty of Agricultural Sciences, University of British Columbia, Vancouver, B.C., Canada, and [3]CEA Cadarache, DSV DEVM LEMIR, UMR 163 CNRS-CEA, Univ-Mediterranee, St. Paul-Lez-Durance, France**
Our study was designed to determine if lodgepole pine and western redcedar derive a biologically significant amount of nitrogen from naturally-occurring endophytic diazotrophs residing within their tissues. Tree stands approximately 40 years old, growing on nitrogen-poor soils in southern and central British Columbia, were selected for isolation of bacterial endophytes. Endophytic bacteria were isolated from internal stem and needle tissues of pine and cedar seedlings using a surface sterilization-tritration-plating technique. Purified isolates were tested for the ability to reduce acetylene to ethylene *in vitro*; those which tested positive for acetylene reduction were subjected to GC-FAME and 16S rDNA analysis for identification. Four diazotrophic strains, *Paenibacillus polymyxa* P2b-2R and P18b-2R, *P. amylolyticus* strain C3b and strain P19a-2R, which was closely related to *Dyadobacter fermentans*, were selected for plant growth trials. Surface-sterilized pine and cedar seed were sown in glass plant tubes filled with an autoclaved mixture of sand and montmorillonite clay treated with an N-free nutrient solution except for 0.35mM $Ca(^{15}NO_3)_2$ (5% ^{15}N label). Each tube was then inoculated with ca. 10^7 cfu of one of the following strains P2b-2R, P18b-2R, C3b or P19a-2R. In the first plant growth trial, cedar foliage derived 23% of its N from the atmosphere 27 weeks after sowing and inoculation with *P. polymyxa* strain P2b-2R according to the calculation:

$$\%\ \text{N derived from atmosphere (\% Ndfa)} = 1 - \frac{\text{atom \% }^{15}\text{N excess (inoculated plant)}}{\text{atom \% }^{15}\text{N excess (non-inoculated plant)}} \times 100.$$

Similarly, pine derived 30% of its foliar N from the atmosphere 35 weeks after treatment with the same strain. In a second plant growth trial of similar design but longer duration, cedar foliage derived 56% of its N from the atmosphere 35 weeks after sowing and inoculation with *P. polymyxa* strain P2b-2R and pine foliage had 66% Ndfa 42 weeks after treatment with strain P2b-2R. Seedlings derived little or no N from the atmosphere after inoculation with the other 3 strains, P18b-2R, C3b and P19a-2R. However, for both pine and cedar, the amount of foliar nitrogen derived from the atmosphere was greatest in the experiment of longest duration, over 50% in both cases, raising the possibility that bacterial fixation becomes a more important nitrogen source as plants age. Strain P2b-2R could be readily isolated from external root tissues at the end of the seedling growth periods, but its presence endophytically could not be confirmed due to persistent contamination on agar plates used to test the effectiveness of the tissue surface sterilization techniques we evaluated. This is the

first demonstration to our knowledge that lodgepole pine and western redcedar can derive what appears to be biologically very significant amounts of foliar nitrogen by inoculation with diazotrophic bacteria originating from within tissues of naturally regenerating gymnosperm seedlings.

CHENG, W. Roots affect turnover rates of soil carbon and nitrogen. University of California, Santa Cruz, CA.

Rhizosphere processes play an important role in soil carbon dynamics and nutrient cycling in terrestrial ecosystems. In this study, the rhizosphere effect of soybean (*Glycine max*) and spring wheat (*Triticum aestivum*) on soil organic matter decomposition was investigated at four phenological stages in a greenhouse experiment using natural ^{13}C tracers. The magnitude of the rhizosphere effect on soil carbon decomposition ranged from zero to as high as 383% above the no-plant control. Cumulative soil carbon loss caused by the rhizosphere effect during the whole growing season equated to the amount of root biomass carbon for the soybean treatment, and 71% of root biomass carbon for the wheat treatment. However, net soil nitrogen mineralization significantly decreased for the soybean treatment and remained similar for the wheat treatment as compared to the no-plant control at the end of the experiment. These carbon and nitrogen budgets indicated that substantial amounts of nitrogen recycled in the rhizosphere. Based on estimates from both ^{13}C measurements and total carbon budgets, the amount of rhizodeposited carbon remaining at the end of the experiment reached 44% and 26% of the total plant biomass for the wheat and the soybean treatments, respectively. These relatively large quantities of substrate input fueled the nitrogen recycling in the rhizosphere most likely through microbial immobilization of the once mineralized soil nitrogen. In summary, the presence of the rhizosphere provided substrate input in the form of rhizodeposits, enhanced soil carbon decomposition, and resulted in a faster turnover of the soil carbon and nitrogen.

CHENG, X.[1] and BAUMGARTNER, K.[2] Root system distribution and arbuscular mycorrhizal colonization of grapevines in a California vineyard. [1]Sustainable Agriculture Research and Education Program, University of California, Davis, CA, and [2]USDA - ARS, Davis, CA.

Fine roots play important roles in grapevine water and nutrient uptake. Vineyard floor management practices, including cover cropping, likely affect grapevine fine root distribution. Knowledge of the effects of these practices on fine roots will aid in our ongoing efforts to determine how cover cropping can be used to enhance grapevine nutrition and to encourage populations of beneficial soil microbes. In November 2002, we conducted a preliminary study in a commercial winegrape vineyard in Napa, CA, to quantify grapevine root system distribution in the soil profile in between vineyard rows, where a no-till cover crop of *Vulpia myuros var. hirsuta* cv. 'Zorro' has been maintained since 1998. Three trenches (180 cm length × 100 cm width × 90 cm height) were excavated perpendicular to vineyard rows from one vine trunk to adjacent trunk. In each trench, nine consecutive soil monoliths (20 cm length ×10 cm width × 20 cm height) were collected at each of four soil depths (0-20 cm, 20-40 cm, 40-60 cm and 60-80 cm). Grapevine roots were extracted by hand and mechanical washing and later separated into fine roots (<2 mm) and coarse roots (>2 mm). Root biomass, length, and arbuscular mycorrhizal colonization were compared with respect to soil depth and distance from the vine trunk. Cover crop root biomass was not quantified in this study because the seeds had just started to germinate.

The biomass of both fine and coarse grapevine roots was significantly greater in the three lower soil depths than in the top soil depth. Fine root distribution did not differ among the three lower soil depths. Coarse root distribution within the three lower soil depths was highly variable among trenches, which made it difficult to compare differences among soil depths. The percentage of very fine roots (<1 mm) was the greatest in the top soil depth. Fine roots were found across the vineyard rows, but root biomass was lower in the center of the vineyard middles (approximately 90 cm from the base of the vine trunk) than in the area close to the vine trunk, especially in the top soil depth. Mycorrhizal colonization was greater in the 0-40 cm than in the 40-80 cm soil depths, but did not differ with respect to the distance from either vine trunk. These results indicate that, in the vineyard we examined, grapevine and cover crop roots coexist in the middle between vineyard rows. This overlap could lead to positive interactions, such as development of a mycorrhizal network among grapevine and cover crop roots, or negative interactions, such as water and nutrient competition and excessive devigoration of grapevines.

CHENG, X.[1] and BLEDSOE, C.[2] Effects of annual grass senescence on $^{15}NH_4^+$ and ^{15}N-glycine uptake by blue oak (*Quercus douglasii*) seedlings, and soil microbes in California oak woodland. [1]Sustainable Agriculture Research and Education Program, and [2]Department of Land, Air and Water Resources, University of California, Davis, CA.

Annual grasses are much stronger competitors for available soil N than blue oak seedlings and soil microbes. However, little is known about the dynamics of N competition after annual grass senescence. We conducted a field experiment in a California oak woodland to study the effects of annual grass senescence on N uptake by blue oak seedlings and soil microbes. Labeled N was applied at the beginning of May and June in the form of $^{15}NH_4^+$ or ^{15}N-glycine. Plants and soils were harvested after 5 days ($^{15}NH_4^+$ and ^{15}N-glycine treatments) and after 26 days ($^{15}NH_4^+$ treatment only). We compared seasonal (May vs June), N form ($^{15}NH_4^+$ vs ^{15}N-glycine) and labeling period (5-day vs 26-day) effects on N competition among blue oak seedlings, annual grasses and soil microbes. There were no seasonal effects (May vs June) on ^{15}N recovery in blue oak seedlings and soil microbes. In May, annual grasses accumulated significant amounts of ^{15}N, and ^{15}N recovery did not differ from that of the soil microbes. ^{15}N recovery was the lowest in blue oak seedlings. In June, very little ^{15}N was recovered in annual grasses due to senescence. More ^{15}N remained in the soil inorganic pool in June than in May. Extremely dry soils in June could limit inorganic N availabilities to blue oak seedlings and soil microbes. N forms did not affect competition among annual grasses, blue oak seedlings and soil microbes, but more ^{15}N was incorporated into the soil organic N pool in ^{15}N-glycine treatments than in NH_4^+ treatments. Over the 26-day labeling period, ^{15}N recovery in annual grasses was either same (May) or less (June), compared to the 5-day labeling period. ^{15}N recovery in blue oak seedlings and the soil organic N pool significantly increased, while ^{15}N recovery in the soil microbial and inorganic N pools both decreased over the 26-day labeling period.

Biomass of blue oak seedlings changed little from early May to late June, but N concentrations in oak roots increased 53%. In contrast, biomass of annual grasses peaked in May, and then decreased rapidly. Our results suggest that blue oak seedlings and annual grasses have different temporal competitive abilities. Blue oak seedlings appear to have a long-term strategy for N competition.

CLARK, J.R.[1], JOHNSON, L.C.[1], and KOELLIKER, J.[2] Response of belowground carbon cycling to water and nitrogen in tallgrass prairie. [1]Division of Biology, and [2]Dept. of Biological and Agricultural Engineering, Kansas State University, Manhattan, KS.

Atmospheric N deposition and water availability may have profound effects on the ability of prairie ecosystems to either sequester C in the soil or release large amounts of carbon into the atmosphere. The specific objectives are to determine the separate and interactive effects of water and N on belowground carbon (C) cycling (soil respiration and root decomposition) and root biomass at Konza Prairie. 2m X 2m plots were treated with 3 levels of water addition, ~85, 50 and 0% of maximum water inputs (250, 150 and 0 mm added in excess of natural precipitation). The water treatments were combined with N additions of 0, 2.5, 5, and 10gN/m^2/season for the last 4 years. Water-N combinations were replicated 6 times in upland and lowland sites. Response variables measured include fine root decomposition, soil respiration (CO_2 efflux), and root biomass. We hypothesize that water supplementation will increase C cycling (soil respiration, root biomass, root decomposition), nitrogen additions will have a neutral or negative effect on C cycling, and that there will be no water and N interactions. Root decomposition was determined by burying ~2g of *Andropogon gerardii* roots in mesh bags in each of the treatments. Decomposition bags were installed in Jan 2002 and a subset harvested May before water-N treatments, in September at treatment end, and one year later. Soil CO_2 efflux was measured using a LiCor 6200 on 14 dates spanning two treatment seasons. Root biomass was quantified from cores collected at the end of the 2002 growing season. After 7 months of decomposition, water increased root mass loss in uplands and lowlands ($p=<.0001$), but high N and high water depressed decomposition in uplands ($p=.01$). However, one year later, N additions had no significant effect on mass loss in upland or lowland. Soil respiration was enhanced in uplands and lowlands with water additions ($p=<.0001$) but was significantly depressed in high N treatment in both topographic locations. Root biomass increased in uplands (62%) and lowlands (57%) in response to water additions ($p<.0001$) but there was no response to nitrogen treatment. Removal of water limitation increases belowground C cycling in tallgrass prairie. In contrast, N addition may depress soil C cycling and lead to greater belowground C sequestration.

CLASSEN, A.T.[1,3], DeMARCO, J.[1], and HART, S.C.[2,3] **Chronic insect herbivory alters microbial biomass, litter microarthropods and community level physiological profiles in a semi-arid woodland.** **[1]Department of Biological Sciences, Northern Arizona University, Flagstaff, AZ, [2]School of Forestry, Northern Arizona University, Flagstaff, AZ, and [3]Merriam-Powell Center for Environmental Research, Northern Arizona University, Flagstaff, AZ.**
Insect herbivores may change nutrient cycling in systems by indirectly altering the abiotic and biotic properties of soil. Previous research in our system has demonstrated that insect herbivores significantly increase litter quality, soil temperature and soil moisture, all factors that drive microbial activity. We used a unique, long-term herbivore removal experiment (17 years) to assess how chronic insect herbivory by the pinyon needle scale (*Matsucoccus acalyptus*) effects litter microarthopod communities and mineral soil microbial biomass, bacterial and fungal community-level physiological profiles, and enzyme activity in a pinyon-juniper woodland. Insect herbivory increased the mineral soil microbial biomass-N and significantly changed community level physiological profiles ($p<0.05$). Herbivores, however, had mixed effects on soil enzymatic activity and litter microarthropod diversity. We propose that these indirect effects of herbivory on litter and soil communities interact with herbivory-caused changes in litter quality and soil microclimate to alter litter decomposition and soil nutrient dynamics.

CORBIN, J.D.[1] and D'ANTONIO, C.M.[1,2] **Nitrogen retention and loss in native- and exotic-dominated California coastal prairie grasslands.** **[1]Department of Integrative Biology, University of California, Berkeley, CA, and [2]Exotic Weeds Research Unit, USDA-ARS, Reno, NV.**
Differences in growth rate, phenology, and tissue chemistry between native perennial bunchgrasses, exotic perennial grasses, and exotic annual grasses have the potential to result in changes to nitrogen dynamics in California grassland ecosystems as community composition shifts. In 1999 we established an experiment to compare N retention and leaching losses between experimental field plots dominated by each group of species. We hypothesized that N leaching losses would be greatest in annual-dominated plots because annuals must germinate from seed with fall rains, and because N loss from litter of these species is faster than from perennial grass litter. Native and exotic perennial grasses, by contrast, maintain live roots and leaf tissue throughout the year. We sampled N leaching

losses using porous-cup lysimeters installed 1 m below the soil surface in each plot. We found that, indeed, nitrate leaching losses in the fall (=wet-up) were significantly greater in annual-dominated plots than in plots dominated by either perennial group. The differences did not persist later in the season as annual plants grew up and sequestered N in their biomass. These greater leaching losses in annual plots at the start of wet-up could have been due to reduced ability of annual vegetation to take up N in the early part of the growing season. To evaluate this possibility, we compared the sequestration of N by soil and plants in annual-dominated and perennial-dominated plots in the first two months of the growing season by adding enriched ^{15}N ammonium to similar 3-year-old assemblages of the three species groups. In spite of the fact that annuals had to start from seed in the fall while the perennials were alive already, annual-dominated plots retained the highest proportion of the ^{15}N ammonium, particularly in vegetation pools. We did not find evidence that decomposition of annual litter led to faster rates of N cycling and, therefore, greater buildup of nitrate in annual plots as compared to perennial plots. We believe that the most likely explanation for the higher rates of nitrate leaching losses in annual-dominated plots is that annual vegetation is less able to take up nitrate that accumulates deeper in the soil profile during the summer and early fall as compared to perennial vegetation. We conclude that the conversion of California grasslands from ecosystems dominated by indigenous native perennial grasses to ecosystems dominated by Eurasian annual grasses has made these habitats less able to retain N in the early fall due to differences in phenology between perennial and annual vegetation. The invasion of annual-dominated grasslands by exotic perennial grasses may revert N retention patterns to ones that more closely resemble pre-settlement conditions.

CORKIDI, L.[1,2], ALLEN, E. B.[1], MERHAUT, D[1]., ALLEN, M. F.[1], DOWNER, J.[3], BOHN, J.[2] and EVANS, M.[2] **Assessing the infectivity of commercial mycorrhizal inoculants in plant nursery conditions.** **[1]University of California, Riverside, CA, [2]Tree of Life Nursery, San Juan Capistrano, CA, and [3]UCCE, Ventura, CA.**

The importance of arbuscular mycorrhizas for horticultural plants is well documented. Inoculation with arbuscular mycorrhizal fungi often improves the growth of many perennial herbaceous and woody ornamental plants. However, horticultural crops are usually grown in soilless potting mixes containing perlite, vermiculite, peat moss and composted barks, and not much is known about the effect of these artificial mixes on mycorrhizal colonization.

We examined the infectivity of several commercial mycorrhizal inoculants in different potting mixes. Corn plants were grown in a soil-based medium and in two different soilless substrates, the commercial Sunshine # 5 mix, mainly composed by Canadian sphagnum peat moss and a potting mix prepared with redwood bark, pine sawdust, calcined clay and sand. Mycorrhizal and nonmycorrhizal plants were grown in "Super Cells" (3.8 cm diameter, 21 cm deep Ray Leach "Cone-tainers", Stuewe & Son, Inc.). The different commercial mycorrhizal inoculants were applied at the moment of transplanting at the rate recommended by each producer. Low rates of Osmocote 18-6-12 and Sierra Micromax were added as sources of N-P-K and micronutrients, respectively. Seven replicates of each treatment were harvested 50 days after planting and the shoot height, total dry mass and percentage of mycorrhizal colonization was recorded.

The percentage of mycorrhizal colonization obtained with the different mycorrhizal inoculants ranged from 0 to 50%. The infectivity of each mycorrhizal inoculant varied widely among the different potting mixes. Mycorrhizal colonization was not related to plant growth. Plants grown in sunshine mix were the tallest and had the greatest dry mass independent of their mycorrhizal status.

DARBY, B.J., NEHER, D.A., and WEICHT, T.R. Protozoan communities in early- and late-successional biological soil crusts of deserts in southwestern U.S. University of Toledo, Toledo, OH.

Protozoan communities were characterized from the Colorado Plateau (southeastern Utah) and Chihuahuan (southern New Mexico) deserts. Ten cores (30 cm deep, 15 cm dia) were collected from beneath early (light, cyanobacteria-dominated) and late (dark, lichen-dominated) stages of biological soil crust development of both deserts in fall 2002. Numbers of flagellates, naked amoebae, and ciliates were quantified for two depths (0-10 and 10-30 cm) using a most probable number technique. Abundance of flagellates, amoebae, and ciliates ranges from 30-1230 (median ~ 95), 122-1065 (median ~278), and 2-84 (median ~ 37) per gram of dry soil, respectively. Greatest differences were noted between deserts, with protozoans more abundant in the Colorado Plateau than Chihuahuan desert. Secondarily, abundance was greater in shallow than deep soils, and late- than early-successional crusts. Ciliates exhibit no discernable trends because of relatively low abundance and high variability. We compared samples frozen in dry ice to samples enumerated in ambient temperatures to distinguish active from encysted protozoa. Proportion of active protozoa was similar across crust type, depth, and location, but varied by organism. Mean percentages of active amoebae, flagellates, and ciliates were 40 to 60%, 50-70%, and 70-90%, respectively. Our observations support the hypothesis that biological soil crusts serve as a refugium for soil microfauna. As microbial grazers, protozoa regulate nitrogen cycling and account for a considerable portion of nitrogen mineralization. We propose that the primary ecosystem services that crusts provide to protozoa communities include nutrient inputs, moisture retention, and temperature stability. These data serve as a baseline for a larger experiment to identify changes in abundance and composition of soil microfauna as a nutritional link between biological crust inputs and vascular plants.

DEGROOD, S.H. and SCOW, K.M. Microbial Community Composition on a Serpentine Soil, Life with Heavy Metals. University of California, Davis, CA.

Serpentine soils, found throughout the world, form from hydrated magnesium silicates, contain high levels of heavy metals, low levels of macronutrients, and a low Ca:Mg. Plant communities are known to differ substantially between serpentine and adjacent nonserpentine soils and plant that hyperaccumulate heavy metals have been well documented. To truly understand the mechanisms for these processes, it is important to understand the microbial community. Also, serpentine soils may also be a benchmark for revegetation and restoration of other heavy metal contaminated sites, such as mine spoils. Again, knowledge of the microbial community could provide valuable insight into the ecosystem processes. However, almost nothing is known of serpentine microbial communities. We compared soil properties and microbial communities in 562 samples of serpentine and nonserpentine soils at McLaughlin Natural Reserve in the California Coastal Range and at a restoration site in Colusa County, Ca. Using correspondence analysis, it was possible to see that serpentine soils were high in Mg and low in Ca, positively correlated with Co, Ni, and pH levels, but negatively correlated with Fe, P, Na, Mn, Zn, K, Cu, H, S, B, and organic matter. Microbial communities (by phospholipid fatty acid analysis) differed substantially between serpentine and adjacent nonserpentine soils. Serpentine communities had a high relative proportion of actinomycete and a low proportion of fungal biomarkers. These results suggest the chemistry and vegetation of serpentine soils select for unique microbial communities. Future work will examine nutrient cycling on serpentine soils.

DRENOVSKY, R.E. and SCOW, K.M. Microbial community composition along a desert dune chronosequence. University of California, Davis, CA.

In the arid western United States natural and anthropogenic changes in basin lake levels have exposed saline, alkaline substrates. At Mono Lake, CA lake level recession has created a dune chronosequence varying in exposure age, salinity, alkalinity, and plant community composition. We investigated how exposure age and soil chemistry influence soil microbial communities, hypothesizing more recently exposed soils would have lower microbial biomass, lower diversity, and decreased fungal:bacterial ratios. Microbial community composition was assessed using phospholipid fatty acid analysis. We controlled for plant effects on rhizosphere communities by sampling soil near the same shrub species, *Sarcobatus vermiculatus*, at three sites along the chronosequence (exposed <10, 60, and >500 years before present, respectively). Correspondence analysis of PLFA data indicated microbial community composition varied by site. Older sites had higher fungal:bacterial ratios and higher diversity (measured as numbers of detected fatty acids). Relationships between exposure age and microbial biomass were more complex, although older sites tended to have higher biomass than the younger site. Canonical correspondence analysis indicated soil salinity, alone, significantly influenced microbial community composition. However, soil salinity was not correlated with total microbial biomass. Although soil C:N and pH did not appear to influence overall microbial community composition, both were negatively correlated with total microbial biomass (P=0.005 and P=0.03, respectively). These results suggest different abiotic factors influence microbial community composition and size at these three sites.

EDWARDS, C.A. and BURROWS, L. Earthworms as test organisms in the ecotoxicological assessment of the impact of pollutants on soil ecosystems. Soil Ecology Laboratory, Ohio State University, Columbus, OH.

Earthworms are key organisms in most managed and natural ecosystems, since they facilitate organic matter decomposition, nutrient release and improve soil structure. For this reason they have been designated as either recommended or required test organisms by the European Union (EU), Organization for Economic Cooperation and Development (OECD), European and Mediterranean Plant Protection Organization (EPPO) and the International Organization for Standardization (ISO) and other national organization and regulatory agencies.

Many methods of testing the acute toxicity of chemicals to earthworms have been described. These include: immersion of earthworms in chemical pollutant solutions, forced feeding of toxicants to earthworms, contact/topical application of pollutants to earthworms, exposure of earthworms to chemical pollutants in natural and artificial soils and silica/glass ball preparations, and some of these methods have been modified and used to also include chronic chemical toxicity assessments. All of these methods will be described, and typical data obtained for several chemicals, including fungicides and heavy metals, presented. However, such single species tests may provide a somewhat artificial assessment of toxicity since they are all based on single-factor assessments of exposure of single species of earthworms to chemicals.

Clearly, to obtain a more realistic assessment of the effects of chemical pollutants on earthworm populations and communities, where other organisms and processes that they interact with are involved, field or semi-field experiments are usually necessary. However, in recent years, we have made considerable progress in using small highly-replicated laboratory soil microcosms or larger intact terrestrial model ecosystems, which contain a wide array of organisms (including plants, microorganisms, and invertebrates such as nematodes, enchytraeids, mites and springtails) with earthworms as a key organism, to assess the broader impact of chemical pollutants on soil ecosystems. As many as twenty end-points are used to assess both ecological, structural (populations of plants and organisms) and functional factors (organic matter breakdown, respiration, enzymatic activity and nutrient transformations) as well as the fate and degradation of the pollutant and its uptake into plant and earthworm tissues. Data on the effects of the fungicide carbendazim on earthworms in single factor assessments, in soil microcosms, in terrestrial model ecosystems and in field experiments will be compared and the relative utility of these methods in assessing environmental impacts of the chemicals reviewed.

FIERER, N.[1], SCHIMEL, J.P.[1], and HOLDEN, P.A.[2] **The relationship between microbial community structure and C dynamics in a soil profile.** **[1]Department of Ecology, Evolution, and Marine Biology, and [2]Donald Bren School of Environmental Science and Management, University of California, Santa Barbara, CA.**
Soil profiles are often many meters deep and may contain significant quantities of microbial biomass and organic carbon at depth. However, the majority of studies in soil microbiology focus exclusively on the surface soil horizons. As a result, we do not adequately understand how microbial community structure and carbon dynamics change with soil profile depth. We studied a 2 m deep profile located in an annual grassland near Santa Ynez, California, USA. Analysis of extracted phospholipid fatty acids show that microbial communities at depth are fundamentally distinct in composition from those at the surface; the proportional abundances of Gram-positive bacteria and actinomycetes generally increase with soil depth while the proportions of Gram-negative bacteria, fungi, and protozoa tend to decrease. These changes in microbial community structure parallel functional differences in microbial carbon processing. Microbial communities in the subsurface have lower carbon substrate use efficiencies and are more limited in their ability to mineralize a diverse array of carbon substrates. Respiration rates in subsurface horizons are more sensitive to temperature than the rates in surface horizons with Q10 values increasing with soil depth. Also, we find that the degree of nitrogen and phosphorous limitation to microbial respiration increases with soil depth. Overall, our data suggest that an increase in temperature or the addition of nutrients to the soil profile is likely to have important implications for carbon sequestration in the subsurface.

FOX, C.A.[1], JARVIS, I.[1], BEHAN-PELLETIER, V.[1], DALPé, Y.[1], CLAPPERTON, J.[1], PRéVOST, D.[1], JOSCHKO, M.[2], and LENTZSCH, P.[2] **Conceptual Framework for Developing an Indicator for Soil Biodiversity at Regional Scales.** **[1]Agriculture and Agri-Food Canada, Research Branch, Environmental Health Team; [2]Centre for Agricultural Landscape- and Land Use Research (ZALF), Germany.**
The diversity of soil organisms provide many benefits to the soil ecosystem such as contributing to breakdown of organic residues and nutrient cycling, formation of soil pores and aggregates, and suppression of soil-borne pests and pathogens. Influences from environmental and anthropogenic stressors can impact on both species and population numbers. Addressing spatial changes in soil biodiversity populations at regional scale is a complex undertaking due to the immense range of soil biota, from microorganisms to macrofauna and the fact that detailed spatial data are for the most part not available. To meet this challenge, modeling techniques that are statistically significant will be needed to facilitate predictions of population numbers. A conceptual framework based on identifying significant interrelationships with soil attributes is being explored as a possible means to predict potential occurrence of soil biota groups. As a proof of concept of the proposed methodology, a draft model for predicting potential earthworm occurrence at regional scale (based on relationships between abundance and soil properties developed in Germany) will be presented. Benefits and challenges of this approach will be discussed in terms of feasibility for a national indicator for soil biodiversity.

FREY, S.D. and KNORR, M. Chronic Nitrogen Enrichment Affects the Structure and Function of the Soil Microbial Community. Department of Natural Resources, University of New Hampshire, Durham, NH.

Inputs to the terrestrial N cycle have doubled in the past century due to anthropogenic activities, particularly fertilizer use and fossil fuel combustion. The biota in many terrestrial ecosystems evolved under low N conditions and thus, one anticipated consequence of elevated N inputs is the change in species composition and/or diversity. There are still major uncertainties in our understanding of how N enrichment will impact the soil community and ultimately ecosystem function. We have begun a study to examine the effects of N enrichment on the relative abundance, diversity, and activity of bacteria and fungi in forest soils exposed to chronic N additions. During fall 2002 we collected and analyzed soil samples from the Chronic Nitrogen Addition Plots at Harvard Forest. One soil core (5.6 cm diam; O horizon plus 10 cm of mineral soil) was collected from four 5 x 5 m subplots within control, low N (5 g N m^{-2} y^{-1}), and high N (15 g N m^{-2} y^{-1}) plots in both a hardwood and pine stand. The samples were analyzed for active bacterial and fungal biomass, microbial functional diversity, and the activities of celluloytic and ligninolytic enzymes. To date, we have found that long-term N additions have decreased total microbial biomass, relative fungal biomass, functional diversity, and lignin-degrading activity. Total microbial biomass was 35 and 38% lower in the high N compared to control plots in the hardwood and pine stands, respectively. The proportion of the microbial community comprised of fungal biomass declined from 70-94% in the control plots to 45-53% in the high N treatments. Catabolic eveness, assessed by measuring the respiratory response of the microbial community to the addition of 25 different C sources, indicates that the functional or metabolic diversity of the microbial community is reduced under long-term N additions. Finally, the activity of phenol oxidase, a lignin-degrading enzyme, was significantly reduced by N enrichment, with a particularly strong effect observed in both the low and high N plots in the hardwood stand. We expect that these changes in the microbial community will be reflected in the quantity and quality of the active soil organic matter pool.

FU, S. and FERRIS, H. Bacterivorous nematodes "farm" bacteria: evidence of positive feedback of predator on its prey. Department of Nematology, University of California, Davis, CA.

Two nematode species (*Cruznema tripartitum* and *Acrobeloides bodenheimer*) were selected to test the hypothesis that nematodes stimulate bacterial growth at low nematode densities. CO_2 production was measured with an infrared CO_2 analyzer as an index of bacterial growth or "bacteria-farming". Three initial population densities (5, 20 and 100) for each species were used in the present study. Our results showed that individual "bacteria-farming" rate of Acrobeloides was significantly higher than Cruznema when initial population density was 5, however, the reverse was true when initial population density was 20. There was no significant difference of the individual "bacteria-farming" rates between these two species when initial population density was 100. Individual "bacteria-farming" rate of either species declined with the initial population density. Individual "bacteria-farming" rate was a better index than collective "bacteria-farming" rate in order to illustrate the importance of species and density in the "bacteria-farming" process. Our results also showed that nematode respiration might be negligible at the beginning of the experiment particularly when initial population was small, however, the importance of nematode to total respiration increased with time and initial population density. The percentage of nematode to total respiration ranged from 3.6 to 8.0 % for Acrobeloides and from 9.2 to 22.2 % for Cruznema when initial population density was 100.

GALLO, M.[1], AMONETTE, R.[2], LAUBER, C.[2], SINSABAUGH, R.L.[1], and ZAK, D.R.[3]
Microbial Community Responses to N amendment in North Temperate Forest Soils.
[1]University of New Mexico, Albuquerque, NM, [2]University of Toledo, Toledo, OH, and [3]University of Michigan, Ann Arbor, MI.
Large regions of temperate forest are subject to elevated atmospheric nitrogen (N) deposition which can affect soil organic matter dynamics by altering mass loss rates, soil respiration, and dissolved organic matter production. In 2001, we studied the to changes in the organization and operation of soil microbial decomposer communities to high levels of N amendment (30 and 80 kg ha^{-1} yr^{-1}) in three types of northern temperate forest: sugar maple/basswood (SMBW), sugar maple/red oak (SMRO), white oak/black oak (WOBO). We measured the activity of extracellular enzymes (EEA) involved directly in the oxidation of lignin and humus (phenol oxidase, peroxidase), and indirectly, through the production of hydrogen peroxide (glucose oxidase, glyoxal oxidase). Community composition was analyzed by extracting and quantifying phospholipid fatty acids (PLFA). EEA responses were consistent across forests types: phenol oxidase and peroxidase activities declined as a function of N dose (33-73% and 5-41%, respectively, depending on forest type); glucose oxidase and glyoxal oxidase activities increased (200-400% and 150-300%, respectively, depending of forest type). Microbial biomass did not respond to N treatment, but nine of the 23 PLFA that comprised >1 mole% of total biomass showed statistically significant treatment responses. In general, EEA responses were more strongly tied to changes in bacterial PLFA than to changes in fungal PLFA. Collectively, our data suggest that N inhibition of oxidative activity involves more than the repression of ligninase expression by white-rot basidiomycetes. In 2002, we investigated the effects of experimental N deposition on dissolved organic matter production. Soil samples were collected from ambient and N-amended plots (80 kg N ha^{-1} y^{-1}). DOC was extracted (2:1, water:soil) from each soil sample. In June and October, bioassays were performed to assess N effects on the composition of DOM and its interacting bacterial community. Each microcosm was profiled by measuring ten extracellular enzyme activities (EEA). DOC concentration was significantly greater in the N-amended soils (on average: 24% higher for SMBW, 9% for SMRO, and 40% for BOWO). The bioassays indicated large displacements in DOM quality and bacterial community function in response to N treatment. In general, the DOM responses to N saturation corresponded to previously reported losses in soil oxidative enzyme activity. Although there is some commonality in the functional response of diverse soil microbial communities to N, differences in community composition and soil organic matter characteristics still confound prediction of N saturation effects on soil carbon dynamics at the ecosystem level.

GRANDY, A.S. and ROBERTSON, G.P. **Soil carbon, nitrous oxide, and aggregation changes immediately following cultivation of an undisturbed soil profile.** **W.K. Kellogg Biological Station and Department of Crop and Soil Sciences, Michigan State University, MI.**
Cultivation of previously untilled soils commonly results in the loss of 40-60% of initial C and N from surface horizons. In the tropics losses typically occur within months of cultivation, but a lack of data for temperate ecosystems prevents similar generalizations on a time scale less than about five years. If the consequences of land-use intensification occur more rapidly than usually assumed, our understanding of agricultural expansion and its impact on soil communities and processes may be altered. We investigated changes in soil C, aggregation, respiration, N_2O production, and denitrification in the first sixty days following cultivation of a previously untilled mid-successional community in southwest Michigan. Cultivation had an immediate impact on all measured properties; within two weeks we found differences in dissolved organic carbon, inorganic N, trace gas fluxes, and field-moist aggregates due to plowing. Cultivation increased the average carbon dioxide flux during the sixty-day study by over 50% and was associated with a decline in water-extractable C. Large, water-stable aggregates rapidly declined following cultivation, likely

providing increased carbon availability for respiration via aggregate destruction. Cultivation increased nitrous oxide fluxes from about 0.62 to 3.3 g N_2O-N ha^{-1} d^{-1}. Differences in inorganic N pools appeared to drive these results: between 30-60 days after tillage, when differences in N_2O fluxes were greatest, soil nitrate concentrations averaged 0.18 μg NO_3^--N g^{-1} in the uncultivated sites and 6.0 μg NO_3^--N g^{-1} in the cultivated sites. Cultivation also reduced denitrification enzymes likely due to rapid aggregate turnover, which reduced the frequency and persistence of anaerobic microsites. The rapid changes in nutrient mobilization observed here have significant implications for understanding the historical impact of agricultural expansion and for mitigating that impact via soil C sequestration and other means.

GRAYSTON, S.J.[1], PRESCOTT, C.E.[2], and LECKIE, S.E.[2] Microbial communities in forest floors under four tree species in coastal British Columbia. [1]The Macaulay Institute, Craigiebuckler, Aberdeen, Scotland, and [2]The University of British Columbia, Vancouver, Canada.

We compared forest floor microbial communities in pure plots of four tree species (*Thuja plicata, Tsuga heterophylla, Pseudotsuga menziesii,and Picea sitchensis*) replicated at three sites on Vancouver Island. Microbial communities were characterized through enumeration of culturable organisms, community level physiological profiles (CLPP), and profiling of phospholipid fatty acids (PLFA).

Thuja forest floors had higher bacteria and pseudomonad populations, actinomycete biomass (PLFA) and potential C utilization than the other species. There were also differences in microbial communities among the three sites: Upper Klanawa had the highest bacterial and pseudomonad populations and highest potential C utilization; this site also had the highest N availability in the forest floors. Forest floor H layers contained greater biomass of bacteria and actinomycetes than F layers based on PLFA, but there were no significant differences in populations of culturable organisms. Fungal biomass displayed opposite trends to bacteria and actinomycetes, being lowest in *Thuja* forest floors, and highest in the F layer and at the site with lowest N availability. In addition to the changes in biomass with tree species and site there were accompanying changes in community composition, with *Thuja* and *Pseudotsuga* forest floors having a much lower fungal:bacterial ratio (0.09 and 0.10, respectively) than *Picea* and *Tsuga* (0.20 and 0.21, respectively). The least fertile Sarita Lake site had a much greater fungal:bacterial ratio (0.31) than the more fertile San Juan and Upper Klanawa sites (0.10 and 0.07, respectively). The similarity in trends among measures of N availability and microbial communities is further evidence that these techniques provide information on microbial communities that is relevant to N cycling processes in the forest floor.

GRIZZLE, H.[1], TISSUE, D.[1], SIROTNAK, J.[2], and ZAK, J.C.[1] The Impacts of Simulated Increased Nitrogen Deposition on Functional Diversity, Biomass, and Species Richness of Soil Fungal Assemblages in the Chihuahuan Desert at Big Bend National Park. [1]Texas Tech University, Lubbock, TX, and [2]Big Bend National Park, TX.

High concentrations of soil nitrogen have been shown to decrease activity, biomass, and abundances of soil fungi. However the effects of nitrogen deposition in low concentrations resulting from atmospheric deposition has not been studied in desert ecosystems. Desert soils are nitrogen limited; therefore any additional inputs of nitrogen will likely alter the species composition, biomass, and functional diversity of soil fungi. We have initiated a study of the impacts of nitrogen deposition on a grassland and oak-pine forest in the Chihuahuan Desert at Big Bend National Park. The study will be made to determine the effects a two-fold and three-fold increase in nitrogen deposition will have on functional diversity, biomass, species richness and abundances of soil fungi in the two vegetation zones along the Pine Canyon Watershed.

Initial differences in nitrogen and carbon utilization between the two fungal assemblages were examined in January 2003 using the Soil Fungilog Procedure employing SFN-2 (carbon source) and PM3 (nitrogen source) microtiter plates. Preliminary results indicate that substrate activity (SA) and total number of carbon compounds utilized (SR) on SFN-2 plates is not significantly different between sites. SA and SR on PM3 plates is also not significantly different between sites. These results suggest that fungal assemblages at both sites would respond in a similar way to increased nitrogen deposition.

GULLEDGE, J.[1,2], JI, B.[1], PORET-PETERSON, A.[1,2], and ENGELHAUPT, E.[1,2]
Temperature and Moisture Controls on CO_2 and CH_4 fluxes in a Coastal Wetland Forest Soil Experiencing Rapid Subsidence. **[1]Institute for Earth and Ecosystem Sciences, Tulane University, New Orleans, LA, and [2]Department of Biology, University of Louisville, Louisville, KY.**
Because of their hydrology, forested wetlands have distinctive carbon dynamics and are important sources of the dominant greenhouse gases CO_2 and CH_4. Soil temperature and moisture are important controls on CO_2 and CH_4 flux rates in wetlands and are thus critical determinants for the flow of carbon from soil to the atmosphere. Coastal bottomlands in southeast Louisiana are experiencing rapid subsidence, which is causing increased seasonal hydroperiod and flooding area in coastal bottomland forests. This study examined the rates of CO_2 and CH_4 flux across the soil surface biweekly over a period of 21 months along a 1 m elevation gradient characterized by frequent long-duration flooding at the low end (Swamp), frequent short-duration flooding in the middle (Intermediate), and rare flooding at the high end (Ridge). Stochastic regression models were used to examine the relationship between flux rates and soil temperature and moisture along this transect. At the current rate of subsidence in the region, conditions at either end of this hydrologic gradient may represent approximately 100 years of change in soil gas fluxes due to subsidence.
Soil temperature was an important control over CO_2 fluxes in all three sites, accounting for 15-57% of the variability in the data. The influence of soil moisture was also important, especially in the Swamp site. Together, temperature and moisture explained 64-73% of the variability in CO_2 fluxes at all sites. CO_2 flux rates were highest in the Intermediate site and lowest in the Swamp. Microbial biomass C also followed this trend and soil respiration exhibited different tolerances to changes in soil moisture across sites, suggesting that the soil communities were acclimated to the prevailing hydrologic regime in each site.
CH_4 emission increased dramatically along the hydrologic gradient from -0.11 g CH_4-C.m^{-2}.y^{-1} in the Ridge site to 2.44 in the Intermediate site and 14.04 in the Swamp site. Soil temperature exerted little control over CH_4 flux. Soil moisture correlated substantially with CH_4 fluxes in the Ridge ($R^2 = 0.57$) site, which was dominated by net CH_4 consumption from the atmosphere, but poorly with CH_4 fluxes in the Intermediate ($R^2 = 0.26$) and Swamp ($R^2 = 0.04$) sites, which were dominated by net CH_4 emission. Nonetheless, moisture obviously controlled CH_4 production, as CH_4 was only emitted when soil moisture was > 50% water-holding capacity.
Assuming that conditions along this hydrologic gradient resemble the effects of future subsidence, and that seawater intrusion does not occur, we predict that CO_2 emissions from forested coastal wetland soils will decrease on average as the land subsides, and that CH_4 emissions will increase. The increase in CH_4 efflux will dominate so that 100 years of subsidence may have a net positive feedback on the greenhouse effect. Aboveground and belowground productivity must be studied to determine whether the whole ecosystem response will have a net negative or positive feedback.

HART, S.C.[1], BOYLE, S. I.[1], KAYE, J.P.[2], GUIDO, D.R.[1], and THOMAS, J.[1] Long-term effects of restoration on the soil ecology of a ponderosa pine - bunchgrass ecosystem.
[1]Northern Arizona University, Flagstaff, AZ, and [2]Arizona State University, Tempe, AZ.
Fire suppression, heavy livestock grazing, and selective harvesting since Euro-American settlement have dramatically altered forest structure in ponderosa pine and other interior forests of the western U.S. Some of the presumed consequences of these changes in fire regimes and forest structure include decreases in soil water content, litter decomposition, and nutrient availability to plants; however, these hypotheses remain largely untested. In 1993 and 1994, an experiment was initiated at the Gus Pearson Natural Area (GPNA) to restore pre-settlement forest structure of a ponderosa pine-bunchgrass ecosystem and to determine whether restoration of forest structure altered ecosystem function. Short-term (1 to 2 y after treatment) measurements at GPNA showed that restoration increased soil temperatures, heterotrophic microbial and autotrophic nitrifier activities, soil nitrogen availability, and ponderosa pine litter decomposition and nutrient release, but had relatively little effect on soil water content. It is unclear, however, if these initial ecosystem responses to restoration are indicative of longer-term responses, and the role the soil microbial community plays in the restoration process. We remeasured these same ecological processes within the GPNA experimental plots to assess the longer-term responses of this ecosystem to intensive ecological restoration treatments, as well as conducted some new assays to increase our understanding of restoration-induced changes in the soil microbial community. Our new measurements included: microbial biomass, fungal and bacterial community-level physiological profiles (CLPPs), and soil enzyme activities. Although restoration continued to enhance soil microbial activity (soil respiration), restoration treatments had no significant effect on the size of the microbial biomass. Both fungal and bacterial CLPPs were altered by the restoration treatments. Furthermore, soil enzyme activities were generally enhanced following restoration. Soil water availability appeared to play a major role in mediating the effects of restoration on the soil microflora; treatment differences were generally eliminated with large increases in soil water content following the onset of the summer monsoon. Overall, our results suggest that restoration-induced changes in vegetation structure (decreased pine biomass, increased grass biomass) and the reintroduction of fire alters the activity and structure of the soil microbial community, while it has little impact on the size of the microbial biomass pool. We speculate that these changes in the microbial community are in part responsible for the increases in nitrogen cycling rates observed in these ecosystems following ecological restoration.

HAWKES, C. and FIRESTONE, M. Impacts of invasive species on root-associated microorganisms and N-cycling in grasslands. **University of California, Berkeley, CA.**
The success of exotic plant invasions and their subsequent impact on ecosystems may be mediated by interactions with belowground microbial and mycorrhizal communities. We used a combination of DNA-based characterization and 15N pool dilution assays of process rates to link changes in plant and mycorrhizal communities with changes in nitrogen cycling. In a California grassland, small alterations of mycorrhizal community composition with exotic grass invasion (*Avena barbata*, *Bromus hordeaceous*) affected nitrogen cycling, with depressed rates of gross mineralization and nitrification when mycorrhizae of exotic grasses were present. Mycorrhizae can alter nitrogen cycling either directly or through effects on bacterial community composition and function. To investigate impacts of invasive species and their associated mycorrhizae on nitrification we used AMO primers to quantify changes in the functional genes involved in nitrification in the California site. We have found that plant invasions can transform belowground microbial and mycorrhizal communities with consequences for ecosystem processes. The success of exotic plant species in novel habitats may be in part dependent on their ability to use or manipulate belowground associations to alter the ecosystem to their advantage.

HE, X., HORWATH, W. R., BLEDSOE, C. S., ZASOSKI, R. J. and TRAVIS, I. W. Belowground transfer of nitrogen among plants in a California oak woodland. Department of Land, Air and Water Resources, University of California at Davis, Davis, CA.
N movement among plants through common mycorrhizal networks (CMNs) has been demonstrated in many greenhouse and field studies. The N movement between plants is often determined to be low in magnitude, especially in short-term greenhouse studies, suggesting that such N movement among plants may be of minor significance. Movement of soil resources among plants through CMNs in the field has received less attention. For this reason, the significance of the movement of limiting resources among plants through CMNs remains poorly characterized. We examined the movement of N among different species of trees and grasses that had either ectomycorrhizae or arbuscular mycorrhizae in a California oak woodland. Our experimental design consisted of 3 tree pairs with foothill pine (*Pinus sabaniana*) being a N donor and receiver plants consisting of foothill pine, blue oak (*Quercus douglasii*) or buck brush (*Ceanothus cuneatus* var. *cuneatus*). We foliarly applied an $^{15}N\text{-}NO_3^-$ solution to isotopically label the foothill pine donor. Pairs of control trees were also included. Trees were selected based on being approximately 2 m in height and separated by distance of approximately 1 m. We collected leaf samples from all trees and grasses between the trees weekly for one month following the $^{15}NO_3^-$ labeling to the donor tree. Roots samples were collected from the donor and receiver trees at 4 weeks by carefully excavating the roots and determining which tree they came from. Samples were analyzed for ^{15}N content. Leaf $\delta^{15}N$ values at week-zero were 2.37, 2.22, -0.12 and 2.51‰ in pine, oak, ceanothus and grasses, respectively. The $\delta^{15}N$ values of the receiver pine, oak and ceanothus leaves and grasses increased steadily over 4 weeks following the $^{15}NO_3^-$ labeling of the donor pine. After 4 weeks, $\delta^{15}N$ leaf values increased to 45.69‰ in the donor pine and 5.72‰ in receiver pine. $\delta^{15}N$ leaf values in the oak and ceanothus receivers and grasses increased to 6.16, 3.70 and 8.12‰, respectively. Control root $\delta^{15}N$ values were 10.36, 14.05 and –0.13‰ for pine, oak and ceanothus, respectively. In the donor pines, root $\delta^{15}N$ values increased to 29.52‰. The receiver tree root $\delta^{15}N$ values increased to 20.84, 19.11 and 8.04‰ for pine, oak, ceanothus, respectively. Transfer of the ^{15}N from the donor roots to the receiver tree roots and grasses occurred at an appreciable rate and amount regardless of the tree pair. Since some of these tree pairs and grasses had either ectomycorrhizae or arbuscular mycorrhizae, direct transfer of N probably did not occur. The enrichment of grasses suggests the root N of the donor tree leaked into the rhizosphere before being translocated among the receiver trees and grasses. The similar $\delta^{15}N$ increase of the receiver tree roots compared to their respective controls suggests that CMNs play an important role in competing and distributing root N among plants.

HENDRIX, P.F. Biological invasions belowground: Interactive effects of native and exotic earthworms on soil processes. University of Georgia, Athens, GA.
The most conspicuous biological invasions in terrestrial ecosystems have been by exotic plants, insects and vertebrates; invasions by soil organisms may be more insidious but have not been as well studied. In particular, introductions of exotic earthworms may be increasing with global commerce in agriculture, waste management and bioremediation. Several cases have been documented in which exotic earthworms have caused significant changes in soil profiles, nutrient and organic matter dynamics, other soil organisms or plant communities. The most dramatic of these changes have been observed in areas previously devoid of earthworms. It is hypothesized that indigenous earthworm fauna and/or characteristics of their native habitats may resist invasion by exotic earthworm species and thereby reduce the impact of exotic species on soil processes. Mechanisms will be explored by which exotic earthworms may succeed or fail to invade habitats occupied by native earthworms, including 1) intensity of propagule pressure (i.e., how frequently and at what densities have exotic species been introduced and has there been adequate time for proliferation?); 2) extent of habitat

matching (i.e., once introduced, are exotic species faced with unsuitable habitat conditions [e.g., soil or climate] or unavailable resources [e.g., unsuited feeding strategies]?); and 3) degree of biotic resistance (once introduced into an otherwise suitable habitat, are exotic species exposed to biological barriers such as selective predation or parasitism, or effective competition by resident native species?). These mechanisms will be discussed with regard to impacts of exotic earthworm invasions on soil processes.

HENEGHAN, L, FATEMI, F., BERNAU, B., RAUSCHENBERG, C., FAGEN K., and WORKMAN, M.A. **The impact of an Invasive Shrub (*Rhamnus cathartica* L.) on soil foodwebs and some ecosystem properties in urban woodland in Chicago, Illinois, and the potential implications for management.** **Environmental Science Program, DePaul University, Chicago, IL.**

The proliferation of invasive species and their effects on local diversity has emerged as a priority issue in ecological conservation. Although the majority of invasive species remain minor components of the invaded assemblages, some species become dominant members, and may as a consequence substantially modify both the composition and the function of ecosystems. There has been increasing attention given to the potential of invasive species to alter aspects of ecosystem function. Though many invasive species may have indirect effects on ecosystem function, seldom are indirect effects quantified. In this contribution we will show that European Buckthorn (*Rhamnus cathartica* L. P. Mill) has altered critical aspects of soil functioning and soil food webs in the urban forests surrounding Chicago. Its leaves, which are high in nitrogen, decompose very rapidly, and it contributes to modified soil fertility. Because of its rapid decomposition, areas of woodland dominated by buckthorn tend to have a greatly depleted litter layer. We show that this contributes to a diminution of microarthropod populations. In addition, we report on a probable link between buckthorn invasion and that of invasive earthworms that are prevalent throughout the urban forest.

HOLLAND, K.J.[1], TOWNSEND, A.R.[1], ORDOYNE, C.[2], CONSTANCE, B.C.[1], and BOWMAN, W.D.[1] **The effect of nitrogen availability on soil enzyme activities in alpine tundra.** **[1]University of Colorado, Boulder, CO, and [2]Mt. Holyoke College, Holyoke, MA.**

Relatively low levels of nitrogen (N) enrichment could have significant impacts in alpine tundra ecosystems. The suggested threshold for alpine tundra N retention is roughly half as much as the rates of deposition our study system sees today, and measurable losses of inorganic N occurs. Yet, feedbacks in the system resulting from changes in soil nutrient stoichiometry and/or microbial communities could either reduce or increase this threshold value. Here, we investigate changes in soil enzyme activity in response to N enrichment and discuss how these changes could mediate N retention and loss in an alpine dry meadow tundra ecosystem. Nitrogen deposition affects the soil nutrient status directly by increasing inorganic N availability, and indirectly by increasing N in plant litter inputs or inciting changes in plant and microbial communities, which subsequently alter rates of decomposition. Our study showed that N enrichment stimulated phosphatase activity and suppressed chitinase activity, which is consistent with findings in most other studies. The responses of lignolytic enzymes are less well understood, and findings are inconsistent across studies. We showed enhanced phenol oxidase activity and decreased peroxidase activity with N enrichment. Recently, there has been suggestion of more rapid lignin turnover with higher N availability in alpine tundra soils; enhanced phenol oxidase activity might help to explain this finding. Greater phosphatase activity suggests that N enrichment increases phosphorus limitation, which ultimately could limit plant growth and net biotic N uptake. Conversely, increased allocation of N to enzyme production would encourage greater biotic N use, increasing total N retention in the system to some degree as N inputs also rise. Resolution of feedback mechanisms between enzyme activities and changes in nutrient supply in alpine tundra may be critical to predicting how these systems will respond to chronic N deposition.

HOOVER, C. M.[1], MAGRINI, K. A.[2], and EVANS, R. J.[2] **Influence of tree species on the chemistry of soil organic carbon. [1]USDA Forest Service, Northeastern Research Station, Irvine, PA, and [2]National Renewable Energy Laboratory, Golden, CO.**
We conducted a pilot study to test the ability of a new rapid analytical technique, pyrolysis beam mass spectrometry (py-MBMS), to detect differences in the carbon signatures of soils near trees of different species. In an Allegheny hardwood stand (cherry-maple), soil samples were taken on transects from the base of the stem to a distance of 5m in each of the four ordinal directions. Eastern hemlock, black cherry, and red maple trees were studied. Two depth increments were sampled; 0-10 cm and 10-20 cm. Samples were analyzed by py-MBMS, and the data were reduced using principal components analysis. The py-MBMS technique was able to distinguish several chemical differences in the chemical character of the soil carbon. Samples from the 0-10 cm depths contain more carbohydrate and lignin carbon, characteristic of recent biomass, while soils from 10-20 cm depth display carbon signatures representative of humics and phenolics, indicating a greater degree of degradation. This trend applied regardless of the distance from the stem or the tree species. Soils in the 0-10 cm layer taken from points 0m or 1m from the base of the stem could be distinguished from samples at 4m and 5m by their carbon signatures as well, with the near group displaying a stronger carbohydrate component than the far group, whose signature was characteristic of highly aromatic compounds. Py-MBMS did not distinguish any well-defined differences in the carbon signatures of soils taken from the black cherry and red maple transects. However, the soils from the hemlock transects were clearly differentiated by their lignin composition, displaying a distinct guiacol signature that separates the hemlock soils from the red maple and black cherry soils. Work continues to identify additional chemical compounds and signatures, and to interpret the ecological significance of the differences in the chemical composition of soil carbon, especially in terms of the degree of recalcitrance. The effect of tree species, and by extension forest type, on soil carbon chemistry has implications for the management of forests and forest soils as carbon sinks.

HORTON, H.[1], RATCLIFFE, A.[2], HORROCKS, R.[3], and MOORE, J.[1,2] **A survey of soil communities within Wind Cave, South Dakota: the influence of productivity on trophic structure. [1]Department of Biological Sciences, [2] Center for Precollegiate Studies and Outreach, University of Northern Colorado, Greeley, CO, and [3]Wind Cave National Park, Hot Springs, SD.**
This study will present three years of survey data in Wind Cave (WC), South Dakota. A steep productivity gradient occurs along the "natural entrance" tour route. Regions near the surface have elevated levels of energy input and are associated with complex food webs. Deeper within WC (or further off tourist trails) there is a loss of energy and thus a loss of trophic structure. The main objective of this study is to investigate the role of productivity (energy) on trophic structure. Preliminary studies at WC have shown it to be at the low end of global productivity (0.1-10 g C m^{-2} yr^{1}). Low-productivity systems have been shown to respond to small changes in energy input. There are approximately one hundred thousand visitors a year at Wind Cave. They represent a large non-natural energy input source for WC, depositing clothing lint, hair and skin cells. Other small mammals leave behind feces along with hair and skin. These along with various abiotic factors represent all energy inputs into WC. A transect was established along the "natural entrance" to asses the effect of energy on trophic structure. Arthropods collected along the "natural entrance" tour route were identified to at least Ordinal level and added to the previous WC food web. Above and below

ground food webs will be presented to show trophic interactions. Soil food webs will be quantified by: micro-arthropod diversity and abundance, bacterial and fungal direct counts, carbon utilization, protozoan and nematode diversity and abundance. Soil food webs at the entrance are complex and similar to those encountered in many soil systems, with up to 4 trophic levels. As the rate of energy input within the cave declines, top predators (level 4) and intermediate consumers (level three) disappear, and the trophic structure collapses to a single level of bacteria and fungi.

HOUSMAN, D., and BELNAP, J. Photosynthetic performance of biological soil crusts under contrasting temperature and precipitation regimes. U.S. Geological Survey, Moab, UT.
Biological soil crusts contribute to several ecosystem processes, including soil stabilization, nitrogen fixation and carbon uptake. Although these living crusts assimilate smaller amounts of carbon than vascular plants per unit area, the large surface area they encompass makes them noteworthy contributors in the carbon budget. In this study, we asked how photosynthetic rates of crusts respond to altered temperature and precipitation by comparing their performance in three sites that differ in temperature and rainfall. Light (*Microcoleous* dominant) and dark (*Collema*-lichen-moss) crusts from the Colorado Plateau (UT) were moved to a warmer site in New Mexico (NM), while crusts from NM were moved to a still warmer site in Arizona (AZ). Within each site we manipulated rainfall inputs so that crusts received either median long-term rainfall or doubled winter rainfall. We found that dark crusts at each site had significantly higher carbon assimilation rates than light crusts, regardless of precipitation regime. Overall, photosynthesis of dark UT crusts increased by 51% when moved from UT to NM, while rates of dark NM crusts decreased by 30% when moved from NM to AZ. Light UT crusts had a 51% increase in photosynthesis when moved from UT to NM, while light NM crusts had an 8% decrease when moved from NM to AZ. Although increased winter rainfall had no significant effect on photosynthetic rates, increased temperature did stimulate carbon assimilation of crusts from the Colorado Plateau. Overall, it appears that the higher temperatures predicted to occur with global warming could increase winter photosynthetic rates in some regions while decreasing them in others. However, it is still unclear how future changes in temperature and precipitation could affect the annual carbon budgets of these crusts.

HUANG, C.-Y. and P.-C. LUCY HOU. Soil macro-fauna increase mite density in a subtropical lowland rain forest of Taiwan. Department of Biology, National Cheng Kung University, Tainan, Taiwan.
Soil macro-fauna include invertebrate predators, which prey on micro-arthropods (collembolans and mites), and detritivores that break up leaf litter. While the predators can potentially decrease the abundance of soil micro-arthropods, the fragmenters may enhance the growth of soil micro-arthropods by making their food available. This study investigated the relationship between soil macro-invertebrates and micro-arthropods by using litterbags of different mesh size (0.1 mm, 1.3 mm, 3.5 mm) in Nanjenshan forest, Taiwan. Litterbags of each mesh size were left in the field for 124 days and three litterbags were collected at an interval of 20 days in August-December, 2000. Invertebrates in the litterbags were extracted by Tullgren funnels and remaining mass of the litter was determined. Mean densities of mites were 127.7, 41.9, and 23.3 individuals per gram dry litter in the coarse-, medium-, and fine-mesh litterbags, respectively, and were significantly different between different mesh sizes. Mean densities of collembolans were 59.1, 27.8, and 32.3 individuals per gram dry litter in the coarse-, medium-, and fine-mesh litterbags, respectively, however, they did not differ significantly between different mesh sizes. Mean densities of mites and collembolans correlated positively with the decay rates. These results suggest that exclusion of soil macro-invertebrates in the fine mesh litterbags decreases the density of mites and may indirectly reduce the rates of decomposition.

INOUYE, R.S.[1] and CHAMBERS, L.[2] Soil profile and resource island development on constructed protective caps in SE Idaho. [1]Idaho State University, Pocatello, ID, and [2]INEEL, Ecological & Cultural Resources Group, Idaho Falls, ID.
The Protective Cap/Biobarrier Experiment (PC/BE) was created at the Idaho National Engineering and Environmental Laboratory (INEEL) in 1993 to test the effectiveness of four cap designs in preventing water from reaching buried waste. Soil for the caps, obtained elsewhere at the INEEL, was a xerollic calciorthid (silty clay loam) consisting, on average, of 19% sand, 48% silt, and 33% clay. The caps, which varied from 1.6 – 2.5 m thick, were built in 20 cm lifts and soil was compacted to a bulk density of approximately 1.29 g/cm^3. Caps used in this study were planted with a mixture of native shrubs, grasses, and forbs. Shrubs were transplanted from the surrounding area. The 8 x 8 m plots were subjected to one of three irrigation regimes: ambient precipitation, 200 mm added in summer, or 200 mm added in late fall or early spring. In 2002 we took 10 cm deep soil cores from under the canopies of sagebrush (*Artemisia tridentata*) and green rabbitbrush (*Chrysothamnus viscidiflorus*) plants, midway from the stem to the canopy edge, and from unvegetated areas 50 cm from those shrub canopies to determine the extent to which vertical soil profiles or shrub-based resource islands had developed in an initially homogeneous soil. Cores were divided into 0 – 5 and 5 – 10 cm increments and analyzed for total carbon and nitrogen content. There were significant differences in C and N content between the 0 – 5 and 5 – 10 cm increments in all locations. Soils under shrub canopies had significantly more C and N in the top 5 cm, compared to soils away from shrub canopies, but there was no effect of shrub canopy on soil C or N content in the lower 5 cm. There was no relationship between shrub canopy size, based on two perpendicular diameters, and the difference in soil C or N between canopy and adjacent unvegetated areas. There was no effect of irrigation on soil N content, but soil C content may have been increased by supplemental irrigation. These results indicate that there was rapid development of both vertical and horizontal heterogeneity in these soils.

JASTROW, J.D.[1], SIX, J.[2], and ULLIAN, J.J.[1] Testing an aggregate-based fractionation technique to detect soil carbon storage in mineral-associated fractions. [1]Argonne National Laboratory, Argonne, IL, and [2]University of California, Davis, CA.
Soil aggregates play an important role in the stabilization of soil organic matter. The intimate associations of decomposing organic matter with soil minerals in aggregates may enable more residues to enter into protected organomineral associations with longer residence times. We developed a technique to physically fractionate particulate- and mineral-associated organic matter according to the hierarchical organization of soil aggregate structure (within microaggregates, within macroaggregates but outside microaggregates, and unaggregated). In addition, silt- and clay-sized fractions from each location were acid hydrolyzed to isolate chemically resistant C from more labile C. We then evaluated the role that aggregate hierarchy plays in the turnover and storage of C in the isolated fractions by using the natural abundance of stable C isotopes following a switch from C4 to C3 grassland. Sixty-two years after the vegetation switch, all particulate organic matter had essentially turned over. However, we found differences in both the amounts and residence times of C in silt- and clay-sized fractions from different locations within the soil's aggregate hierarchy.

JASTROW, J.D.[1], O'BRIEN, S.L.[1], VAN TIL, B.E.[1], MATAMALA, R.[1], SWANSTON, C.W.[2], and HANSON, P.J.[3] Incorporation of a whole ecosystem radiocarbon label into unprotected and protected soil carbon pools. [1]Argonne National Laboratory, Argonne, IL, [2]Lawrence Livermore National Laboratory, Livermore, CA, and [3]Oak Ridge National Laboratory, Oak Ridge, TN.

A unique, large release of $^{14}CO_2$ occurred near Oak Ridge, TN in July/August 1999. At a local level, this pulse label was similar to or larger in magnitude than the pulse of ^{14}C produced by atmospheric weapons testing. At four sites consisting of two soil types (an ultisol and an inceptisol) and two levels of ^{14}C exposure in 1999, replicated permanent plots were established in fall 2000 for the manipulation of forest litter through multi-year reciprocal transplants of enriched vs. near background litter. As a part of a cooperative, multi-institutional study, the differently labeled root and surface litter sources are being used to track the nature, source, and dynamics of soil organic matter pools. Mineral soil samples (0-15 cm) collected in January 2001 (before the first surface litter application but after two growing seasons of root-enriched inputs) were fractionated into unprotected and microaggregate-protected particulate organic matter (POM), microaggregated silt and clay, and silt and clay located outside microaggregates. Radiocarbon analyses of physically fractionated soil carbon pools from enriched vs. near background sites suggest substantial incorporation of new carbon derived from fine root sources into unprotected and protected POM in both soil types and lower, but significant, incorporation of new carbon into mineral-associated pools in the ultisol.

KAFFE-ABRAMOVICH, T. and STEINBERGER, Y. The effect of soil biota on the rate of *Zygophyllum dumosum* leaf weight loss in a desert soil ecosystem. Faculty of Life Sciences, Bar-Ilan University, Ramat-Gan, Israel.

Decomposition of organic matter in soil is a complex process involving many inter-relationships between various decomposers. In arid systems, the essentialness of the biotic factor is elucidated by water scarcity. Our goal in the current study was to determine the contribution of the soil-inhabiting decomposer community on organic matter weight loss.

The decomposition process was studied using the leaves of *Zygophyllum dumosum*, a perennial desert plant, treated with the chemical inhibitors Nemacur (nematocide) Edigan (biocide), and water; while soil samples from the open field served as control. Litterbags containing the leaves were implanted in the soil at a depth of -10 cm in November 2000, in the northern Negev, Israel, and along with the soil samples, were collected monthly from the study site for determination of weight loss, microbial functional diversity, organic matter, and water content. The results were statistically analyzed; PCA (principal component analysis) and Shannon Weaver Index (H') were calculated. Results obtained in this study showed the strong effect of inhibitors on decomposition rates, with the water-treated group showing the most rapid weight loss of 62.2% mass remaining at the end of the study, compared to the groups treated with Nemacur and Edigan. PCA results for the inhibitors were adjusted according to the PCA values for the soil used as control and were divided into three substrates (carboxylic acids, carbohydrates and amino acids), showing distinct patterns. There was a general increase towards negative distribution in carbohydrate substrates; there was a convergence into a homogeneous community in carboxylic acid substrates in the spring; while the amino acid substrate showed a convergence from a closed to an open, heterogeneous community. The Shannon Weaver index indicated different levels for the inhibitors compared to the soil samples. The highest value was obtained for the water-treated sample, followed by Edigan, while the lowest Shannon Weaver index values were obtained for the Nemacur-treated leaves.

Our findings elucidate the importance of the soil biotic community in controlling organic matter weight loss in a desert soil ecosystem.

KANEKO, N.[1], ITO, T.M.[1], TOYOTA, A.[1], HASHIMOTO, M.[1], and KOIDE, R.T.[2] Linking the periodical millipede to plant growth periodicity. [1]Yokohama National University, Yokohama, JAPAN, and [2]The Pennsylvania State University, PA.

The periodical millipede (*Parafontaria laminata*; Xystodesmidae) has been known for its exact 8 years periodical swarming of adult high-density populations in foothills of Mt. Yatsugatake, central Japan. We established four study sites having different millipede density, similar vegetation and soil type. All individuals became adults at the end of August 2000 and all died by August 2001 after reproduction. The soil carbon and nitrogen contents, soil aggregates, bacteria and fungal biomass, mycorrhizal community and soil fauna were surveyed. Both soil chemical and biological properties reflected the millipede density. Growth of canopy tree (larch) and shrub (dwarf bamboo) responded to the adult occurrence. Cumulative soil change and periodical plant growth change were suggested, thus we concluded that the periodical occurrence of adult millipede induced a periodical plant growth in this ecosystem.

KILLGORE, A.J. and WHITFORD, W.G. Spatial and temporal characteristics of biopedturbation on a semi-arid rangeland: Effects on soil quality and seedling recruitment. New Mexico State University, Las Cruces, NM.

Animal interactions with the soil have proven to have important effects on soil properties and organic matter distribution in arid and semi-arid regions. We monitored the rate of all surface biopedturbation on 5 ecological sites, measured their distance to nearest vegetation and volume, and identified which organismal guild created them. A comparison of disturbed and undisturbed soil revealed significant differences in infiltration rates and litter weight. We measured fetch lengths for each site and placed erosion pins in mechanically dug pits at ½ and ¼ distance of barepatches, and at the base of dominant vegetation. Biweekly monitoring revealed no significant differences in infilling rates between sites or barepatch position. We estimate average infilling rates for the Jornada basin to be 0.57 cm/month. Contribution of biopedturbation to the spatial distribution of seedling recruitment and labile organic carbon will be made.

KNORR, M.A.[1], FREY, S.D.[1], and CURTIS, P.S.[2] A Meta-Analysis of Nitrogen Enrichment Effects on Litter Decomposition. [1]Department of Natural Resources, University of New Hampshire, Durham, NH, and [2]Department of Evolution, Ecology, and Organismal Biology, Ohio State University, Columbus, OH.

Nitrogen deposition rates near industrialized and agricultural areas can greatly exceed those in unpolluted areas. The effect of N enrichment on decomposer organisms and the decomposition process is unclear, even though numerous experimental studies addressing this issue have been initiated. Several studies have reported significantly faster litter decay rates in response to increased external N availability, while many others have reported either no significant change or a suppression of decomposition. To synthesize existing data, we conducted a meta-analysis of previously published empirical studies that have examined the effects of N enrichment on litter decomposition. Meta-analysis offers formal statistical methods for comparing and integrating the results of multiple studies. More specifically, we examined how N fertilization interacts with temperature, precipitation, and ambient N deposition to influence annual decay rates and litter mass loss. We reviewed nearly 900 litter decomposition studies published since 1980 and identified a subset of 32 studies where external N availability was experimentally manipulated. A prior devised criteria required that each study had focused on leaf litter decomposition along a discernable N addition gradient, whether a laboratory or field study. Furthermore, studies must have reported initial litter mass and mass remaining or decay rates for each experimental and control observation. Studies that did not clearly express data for these two variables were not included. For the majority of studies, data on mean annual temperature and precipitation, as well as ambient N deposition levels were collected and their effect on decomposition was determined where applicable. For each comparison, the treatment effect size estimator, or the standardized difference between the means of the experimental and control groups was estimated. When all sites were analyzed together, we found that N additions did not have a significant stimulatory or inhibitory effect on litter decomposition rates. However, interesting trends emerged when sites were separated by mean annual temperature, precipitation and ambient N deposition. For example, at sites with low mean annual precipitation (< 850 mm), a low level of N fertilization had a stimulatory effect on litter mass loss. All other combinations of precipitation and N enrichment were found to have no effect when compared to controls. Additionally, decomposition at sites with low ambient N deposition levels (0-3 kg/ha/yr) was stimulated by moderate N fertilization. Under higher ambient N deposition regimes, a trend toward increasing inhibition of decomposition was observed as N fertilization rates were increased.

KUPERMAN, R.G.[1], SIMINI, M.[1], PHILLIPS, C.T.[1], CHECKAI, R.T.[1], KOLAKOWSKI, J.E.[1], KURNAS, C.W.[1], AND SUNAHARA, G.I.[2] **Soil invertebrate-based Ecological Soil Screening Levels (Eco-SSL) for explosive contaminants in soil.** **[1]U.S. Army Edgewood Chemical Biological Center, Aberdeen Proving Ground, MD, and [2]Biotechnology Research Institute, Montreal, QC, Canada.**

We investigated the toxicity of the energetic materials (EM), hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), 2,4-dinitrotoluene (2,4-DNT), 2,6-dinitrotoluene (2,6-DNT) and 1,3,5-trinitrobenzene (TNB) to soil invertebrates. The study was designed to develop Ecological Soil Screening Level (Eco-SSL) benchmarks for ecological risk assessment (ERA) of EMs at contaminated sites. Eco-SSLs are ecotoxicity values that can be used in screening ERAs to identify contaminants in soil that warrant additional evaluation in a baseline ERA, and to eliminate those that do not. Test species included the soil invertebrates *Eisenia fetida* (ISO 11268-2:1998), *Enchytraeus crypticus* (ISO/16387:2001), and *Folsomia candida* (ISO 11267:1998). Tests were conducted under conditions preferred for Eco-SSL derivation using a Sassafras sandy loam soil that supports relatively high bioavailability of EM. Simulated weathering/aging of amended soil was incorporated in the experimental design to better assess the toxicity potential in the field. Exposure concentrations were measured as total (acetonitrile-extractable) chemical concentrations. These concentrations were correlated with reproduction endpoints to develop ecotoxicological parameters for EMs based on concentration-response relationships. Data were analyzed using nonlinear regression models to produce EC_{20} and EC_{50} values based on EM concentration vs measurement endpoints. Draft Eco-SSL values were developed from EC_{20} values for juvenile production by the three test species. Results of these studies will undergo quality assurance by the Eco-SSL task group before inclusion in the Eco-SSL database.

LACHNICHT, S.L.[1], SCHOMBERG, H.H.[1], and TILLMAN, G.[2] **Differences in the soil microarthropod community under two winter cover crops in strip-tilled cotton.** **[1]USDA-ARS, JPCSNRCC, Watkinsville, GA, and [2]USDA-ARS CPMRU, Tifton, GA.**

It is understood that implementing conservation tillage practices will improve soil quality. Increased soil organic matter under conservation tillage supports the development of the soil biotic community. Organic matter quantity and quality influence soil microarthropod abundance and diversity. Our objective was to examine the microarthropod community as an indicator of the impact of cover crop and strip-tillage, a conservation tillage practice, on soil quality. We examined microarthropod community differences strip-tilled cotton planted into two different winter cover crop fields (legume blend, rye-legume blend) over a two-year period. Results from the first year indicated seasonal changes in abundance and diversity of mites. In this first year Prostigmata were the most abundant across all fields and seasons, on average making up greater then 40% of the community. Astigmata and insects, exclusive of Collembola, were rare, generally less than 5% of total abundance.

Abundance and diversity of microarthropods were highest in mid-season samples. Abundances of all microarthropod groups were greatest in the Blend in the pre-season, greatest in the Rye-legume Blend mid-season, and apparently not different between cover crops in end-season samples.

LANNO[1], R.P. and MCCARTY, L.S.[2] **Issues at the interface between soil ecology and ecotoxicology.** **[1]Ohio State University, Department of Entomology, Columbus, OH, and [2]L.S. McCarty Scientific Research and Consulting, Markham, ON, Canada.**
The integration of soil ecology and ecotoxicology is absolutely necessary for the proper management of soil contaminated with toxic chemicals. Although facing many similar problems, there are differences between soil ecology and ecotoxicology in the nature and aspect of some of the major issues related to contaminated soils. Scientific challenges relate to the fundamentals of both toxicology and ecology. Many questions arise in establishing dose-response relationships in soil systems such as: What are the most suitable metrics of dose and response? Another issue is the development of suitable methods for the extrapolation of results from lab to field. There is a need to define what constitutes adverse effects in soil systems, both from the perspective of what changes in soil ecological structure and function can be categorized as adverse responses and what changes are actually measurable. Policy challenges are related more to the use of soil ecology in public policy and regulations; essentially, where and how soil ecology can be used in decision-making. Another policy issue is conveying the importance of soil ecology, in terms of community structure and function, to regulators and policy makers. As both toxicology and soil ecology are employed in actions on environmental matters, interactions between policy decision-making and scientific knowledge generation are also examined.

LECKIE, S.E.[1], PRESCOTT, C.E.[1], GRAYSTON, S.J.[2], NEUFELD, J.D.[1], and MOHN, W.W.[1] **Soil microbial communities in forests that differ in nitrogen availability.** **[1]University of British Columbia, Vancouver, BC, Canada, and [2]Macaulay Land Use Research Institute, Aberdeen, UK.**
We addressed the linkage between soil microbial communities and soil processes by comparing the microbial community structure in humus layers of two forest types with substantially different soil nitrogen availability. Two common coniferous forest types of northern Vancouver Island, British Columbia occur adjacently yet differ in nutrient availability and productivity. Cedar-hemlock (CH) forests have low nitrogen availability and poor regeneration after harvesting. Hemlock-amabilis fir (HA) forests have higher nitrogen availability and exhibit much greater productivity after harvesting. We also sampled young regenerating forests of western hemlock and of planted western redcedar on each of CH and HA cutovers that were unfertilized or fertilized with nitrogen, to address the effects of those silvicultural practices on the forest soil microbial communities. Denaturing gradient gel electrophoresis (DGGE), ribosomal intergenic spacer analysis (RISA), and phospholipid fatty acid (PLFA) profiles were used to compare the bacterial and fungal communities and give an estimate of the relative biomass of bacteria and fungi. In the unharvested forests, microbial communities were distinct in each of three forest floor layers. Differences between the forest types were detected only with PLFA analysis of the whole community and RISA profiles of the fungal community. Fungal PLFAs were significantly more abundant in the poor CH forests than HA and the fungal community differed between the two forest types. Bacterial PLFAs were proportionally more abundant in HA forests than CH in the lower humus layer and there were proportionally more Gram-positive bacteria in HA forests. In regenerating forests, community level physiological profiling (CLPP) and PLFA analyses were used to compare the communities. In addition, there was discrimination of the samples based on the cutover type and fertilization treatments.

LINDO, Z. and VISSER, S. Does reduced abundance of soil mesofauna following clear-cutting alter decomposition / nutrient cycling processes in coniferous forests? University of Calgary, Calgary, AB, Canada.

Forest clear-cutting significantly reduces population densities of soil mesofauna and these reductions may persist for years. Soil mesofauna are important in decomposition and nutrient cycling processes as they catalyse primary decomposition and regulate microbial populations, which mediate carbon, nitrogen and phosphorous cycling. The implications of reduced mesofauna abundance on decomposition and nutrient cycling processes in harvested coniferous forests were determined using a laboratory mesocosm study. We examined the effects of mesofauna densities, that simulated field densities, on microbial biomass, soil respiration, decomposition potential, available nitrate, available ammonium and available phosphate in uncut and clear-cut coniferous forest floors. Mesofauna abundance in both forest floor types increased during the 60-day duration of the experiment. Increased mesofauna abundance had a positive effect on microbial biomass and available phosphate. There was no significant effect of mesofauna abundance on mass loss from decomposing aspen leaves, soil respiration, available ammonium levels or available nitrate levels in either forest floor. This study suggests that the stimulating effect of soil mesofauna on microbial growth can indirectly affect other soil parameters, such as phosphate levels. This study also suggests that forest floor mesofauna populations possess the ability to recover from low population densities that occur following forest harvest.

LIPTZIN, D.[1, 2], and SEASTEDT, T.R.[1, 2] The effect of trees on soil carbon and nitrogen in the forest-tundra ecotone, Niwot Ridge, Colorado. [1]Institute of Arctic and Alpine Research, and [2]Department of Environmental, Population, and Organismic Biology, University of Colorado, Boulder, CO.

A unique unidirectional flux of materials characterizes the forest-tundra ecotone (FTE) on Niwot Ridge, Colorado. In the alpine it is known that topography affects the redistribution of resources. Trees at treeline are hypothesized to accumulate water nutrients, and organic matter by functioning as snow fences. These inputs would subsidize the biota in the FTE as they provide moisture, carbon, nitrogen, and base cations to the soil. This transported material likely includes nitrogen of anthropogenic origin. These subsidies were hypothesized to be greatest nearest the alpine tundra, the source of the material, and downwind of trees, because of the tree-wind interaction. The goal of this research was to look for indirect evidence for this redistribution by measuring the total pools of carbon and nitrogen, nitrogen cycling rates and resin bag available nitrogen. Total carbon and nitrogen and measured at four locations around individual trees (upwind, downwind, below, adjacent tundra) at three sites across the FTE (tree island, upper krummholz, and lower krummholz) and in the closed forest. In situ nitrogen cycling in buried bags and resin bag available nitrogen were measured at two locations around individual trees at two sites across the FTE (tree island and lower krummholz) and in the closed forest during the growing season. Total carbon and nitrogen generally increased with altitude across the ecotone and were higher downwind than upwind of trees. Resin bag available nitrogen was greater downwind of trees than upwind of trees and decreased with elevation. The predominant form of nitrogen was nitrate. Nitrogen mineralization was also lower upwind of trees than downwind of trees, significantly so at the tree island site, and increased with elevation. At the closed forest site, ammonium was the dominant form of nitrogen produced, but nitrate was more abundant at the higher elevation sites. These results indicate the spatial heterogeneity in soil pools and fluxes of nutrients. Future work aims to link these processes directly to the eolian inputs, quantify the inputs and losses of nitrogen to these soils and determine if this ecotone, or select locations within it, is approaching nitrogen saturation.

MADSON, S. L. and COLEMAN, D. C. Finding common ground: Microhabitats as a compatible spatial scale between soil microarthropod communities and harvested forest stands in the southern Appalachians. Institute of Ecology, University of Georgia, Athens, GA.
Forest stands are harvested on a scale of several hectares, whereas most microarthropods will spend their entire lives within a scale of several meters. Rarely is this mismatch between spatial scales accounted for when examining the response of soil microarthropods to forest harvesting methods, such as two-age regeneration treatments. Microhabitats, for example mature trees left as refugia, coarse woody debris piles, grassy clearings, shrubs, and coppices, are created or exacerbated by the harvesting process. In other ecosystems, such as Mediterranean scrub lands or Pacific Northwest forests, microhabitats have been shown to be a determining factor in microarthropod community composition. We examined microhabitats as a common spatial unit to assess the response of soil microarthropods to two-age regeneration treatments within hardwood stands at Wine Spring Creek Watershed in the southern Appalachians. Microarthropods were extracted using modified Tullgren extractors and sorted to sub-order. Natural spatial heterogeneity in the soil microarthropod communities was high in both the control and cut sites. The majority of the microarthropod taxa showed the greatest response to harvesting when examined at the scale of microhabitats. Microarthropod abundance was lowest in skid rows and was highest in coppiced and mature tree microhabitats. Using microhabitats as a common spatial scale between microarthropod communities and harvested forest stands appears to be a useful tool in elucidating treatment effects within the high natural heterogeneity of microarthropod communities in forest stands.

MARSE, T.J. and WHITBECK, J.L. Assessment of aboveground litter decomposition rates across a hydrologic gradient in bottomland hardwood forest of the Lower Mississippi Alluvial Valley. University of New Orleans, New Orleans, LA.
We estimate aboveground litter decomposition rates across a 1.0-m elevation gradient in mature bottomland hardwood forest in Jean Lafitte National Historical Park and Preserve, Jefferson Parish, Louisiana, USA. Hydrology changes significantly along this gradient, such that the high elevation is rarely flooded, while the low elevation experiences standing water for several months each year. We hypothesized that litter decomposition rate would be slowest at the wet end of this gradient, and that dry summer conditions at the high elevation site would also diminish the rate of decomposition. To assess aboveground decomposition rates, we measured litter mass change over time by placing known quantities of oven-dried litter into fiberglass screen bags and deploying the bags on the forest floor for varying exposure intervals. We placed groups of litterbags at five randomly chosen replicate locations at each of three sites (ridge, intermediate, swamp) along the hydrologic gradient. To estimate initial decomposition rates, we collected litterbags each month for six months, then bi-monthly to one year. We plan additional sampling at 15, 18, and 24 months after installation to assess longer-term rates.
The data for the first three months of collection (December, 2002 through February, 2003) indicate a steady decrease in mass at the wettest site (swamp) with a decomposition rate of 0.03 g dw per day. We observed an unexpected increase in mass during the first 60 days at the drier sites (ridge and intermediate), which was then followed by a decrease similar to that observed at the swamp site. Close inspection of litter collected from the ridge and intermediate sites suggests that one or more organisms may be using the leaf litter at these sites as a substrate, adding mass to the litter.

McLEAN, M.A.[1] and CARREIRO, M.M.[2] Relationship between fungal enzyme activity, litter age and nitrogen levels in rural and urban oak forest floor. [1]Department of Life Sciences, Indiana State University, Terre Haute, IN, and [2] Biology Department, University of Louisville, Louisville, KY.

We used the contrasting soil horizon development existing in forests at the endpoints of an urban-to-rural gradient to explore its effect on the relationship between fungal enzymatic activity and inorganic nitrogen content. To examine these relationships as litter ages, plots were sampled just after litterfall in November 1999, and in October 2000 before litterfall. We assessed enzyme production (phosphatase, β-glucosidase, phenol oxidase, peroxidase, ligninase (phenol oxidase + peroxidase)), fungal biomass (ergosterol) and net N mineralization in forest floor and soil. In the rural site NO_3^- levels are low in forest floor and soil (0.3 and 0.1 μg NO_3^-N g^{-1} DW, respectively) while in the urban site NO_3^- levels are higher (4 and 3 μg NO_3^-N g^{-1} DW, respectively). Total enzyme activity μg^{-1} fungal biomass (ergosterol) and the proportion of enzyme activity devoted to phosphatase and β-glucosidase was significantly higher in newly fallen litter than in 1 y old litter in the rural site but not in the urban site. The proportion of enzyme activity devoted to phenol oxidase, peroxidase and ligninase was lower in newly fallen litter than in 1 y old litter in the rural site, but not in the urban site. That there was no significant difference in enzyme activities in the urban site between newly fallen litter and 1 y old litter probably reflects almost complete consumption of the litter by earthworms each year. In the rural site, the initial NO_3^- content was positively correlated with phosphatase and total enzyme activity μg^{-1} fungal biomass. In the urban site, initial NH_4^+ was positively correlated with ligninase activity μg^{-1} fungal biomass.

MEDING, S.M., ZASOSKI, R.J., and BEAUDETTE, D.E. Transfer of ^{15}Nitrate and Rare Element Analogs of Phosphorous, Potassium, and Calcium through Common Mycorrhizal Networks for Grass and Forb Species of the Sierra Foothills of California. Soils and Biogeochemistry, University of California, Davis, CA.

Arbuscular mycorrhizal fungi infect the majority of plant species found within the savannah/oak woodland ecosystem of the California Sierra Foothills. These fungi have the potential to form underground networks which link the roots of individual plants and/or species of plants. A common mycorrhizal network (CMN) may function as an efficient transport mechanism for the movement of nutrients between plants. An experiment was conducted, as part of an on-going study, to examine the transfer of macronutrients between plants restricted to mycelial connections. Specialized growth containers, designed to separate plants with double root restrictive screens and an air-gap, were used to prevent the movement of nutrients between plants by root transport or soil solution mass flow. Nutrient labels applied to the foliage of donor plants were then analyzed for detection in the foliage of receiver plants. In order to examine the potential movement for an array of plant macronutrients through a CMN, a stable isotope and rare element nutrient analogs were used as tracers. ^{15}Nitrate was used to trace nitrogen movement. Arsenic, cesium, rubidium, and strontium were used as tracers for phosphorous, potassium, and calcium respectively. Treatments included separated monocots, dicots, and a mixture of grass and forb species common to a California Sierra Foothill research site. The treatments were set up to encompass two levels of plant biocomplexity. Results showed positive transfer of the nitrogen isotope and the phosphorous and potassium analogs within most treatments. Receiver foliage concentrations averaged up to 887%, 164%, 2898%, and 80% above control concentrations for ^{15}nitrogen, arsenic, cesium, and rubidium respectively. The calcium analog did not show significant transfer for any of the treatments. Behavior of the tracers differed based on the nutrient each represented, with the exception that each positively transferred tracer showed high transfer concentration gradients for the treatment with highest level of plant biocomplexity.

MEIMAN, P.J., REDENTE, E.F., and PASCHKE, M.W. The role of the soil community in the invasion ecology of two exotic knapweeds. Colorado State University, Fort Collins, CO.
Invasive, exotic plants occupy large portions of North America and continue to spread. Some of the most damaging plant invaders of North American rangelands belong to the group of exotic weeds known as the knapweeds. Prolific seed production, allelopathy and sheer competitive ability are commonly identified as the mechanisms that allow knapweeds to invade native rangeland systems. Recently however, a number of investigators have begun to study the role of soil organisms in the invasion ecology of knapweeds. The objectives of this study were: (1) compare the relative benefit that selected native plants and two exotic knapweeds derive from the soil community associated with native, un-invaded rangelands; (2) determine whether or not diffuse and spotted knapweeds maintain conditions in the soil that favor the regeneration of knapweeds over native plants. These objectives were addressed in a greenhouse study where individuals of native plants and knapweeds were grown in various soil treatments (core of knapweed infestation, perimeter of knapweed infestation, un-autoclaved (intact) native soil, and autoclaved native soil). A fertilizer treatment was included to allow separation of the effects of autoclaving on nutrient availability from its effects on the soil community.

All species responded similarly to fertilizer, but not to autoclaving. Diffuse knapweed, and the two native plants tested, grew better in autoclaved native soil than intact native soil. Conversely, spotted knapweed grew better in the intact native soil than the autoclaved native soil. Total biomass per pot for all species tended to be higher in the native soil than soil from either the core or perimeter of knapweed infestations. Emergence of both spotted and diffuse knapweed was highest in soil from knapweed infestations, but no obvious trend in emergence was evident for the native plants.

The soil community had a net negative effect on the growth of 2 native plants and diffuse knapweed, but a net positive effect on the growth of spotted knapweed. Therefore, spotted knapweed appears to derive greater benefit from the soil community associated with the native rangeland soils tested than diffuse knapweed or the two native plants tested. This interaction with soil organisms may help explain the ability of spotted knapweed to invade native rangeland systems.

MELVILLE, K.M. and MOORE, J.C. Modeling trophic interactions in a cave ecosystem. University of Northern Colorado, Greeley, CO.
The objectives of this study were to determine the nature of the functional response of *Folsomia candida* on its fungal prey, to explore the differences between different functional responses on the dynamics and stability of the interaction. Many basic theories on trophic structure, dynamics and stability were formulated using models based on a Type I, or linear, functional response. Empirical studies have shown that most organisms, particularly invertebrates, exhibit a Type II, saturating, functional response. Microcosm of 2% water agar and various densities of fungal plugs, were used to determine the type of functional response for *F. candida* on three different species of fungus (*Pencillium notatum*, *Geosmithia putterillii*, and *Tritirachium sp.*) and at three different temperatures (15°C, 20°C, and 25°C). *F. candida* demonstrated a Type II functional response with all prey species and at all temperatures. The magnitude of the response did shift at the various prey and temperatures but did remain a Type II. Models comparing Type I and Type II functional responses, using parameters estimated from the experiments, exhibited markedly different dynamics. Models possessing Type I functional response were more likely to persist and were less prone to oscillations then their counterparts possessing a Type II functional response.

MIGGE, S.[1], PARKINSON, D.[2], and SCHEU, S.[3] Earthworm invasion of Canadian aspen forest soils: impact on soil microarthropod communities. [1]University of Göttingen, Göttingen, Germany, [2]University of Calgary, Calgary, Alberta, Canada, and [3]Darmstadt University of Technology, Darmstadt, Germany.

The last glaciation eradicated the native earthworm fauna of Canada. With the advent of European settlers earthworm species native to the old world started to invade North America. Since then earthworms have changed the structure of North American soils dramatically. Surprisingly little is known about the impact of this invasion on the indigenous soil fauna. In western Canada large areas still are free of European earthworms but rapid colonization has been documented during the last decades. The most rapidly spreading earthworm species include the epigeic *Dendrobaena octaedra* and the mineral soil dwelling *Aporrectodea caliginosa, Lumbricus terrestris*, and *Octolasion tyrtaeum*.

In the present study mineral soil dwelling species were used in field and laboratory experiments to study their effect on microarthropod communities in aspen forest soils near Calgary (Alberta; Canada). Generally, microarthropod groups were detrimentally affected by earthworm activity due to the processing of organic material and mixing of mineral soil with organic matter. The fact that earthworms, collembolans and oribatid mites feed on similar food resources led to competition for food resources. In comparison, densities of microarthropods in treatments with earthworms were similar in litter and earthworm casts, and in organic and mineral substrates, whereas abiotic and microbial properties of these substrates differed significantly. This indicates that in addition to earthworm-mediated changes in food availability and competition, microarthropods were affected directly by mechanical disturbances due to burrowing, feeding and casting of earthworms. Disturbance by earthworms was very strong in the laboratory systems leading almost to extinction of oribatid mites in treatments with two earthworm species.

MILLER, A.E.[1], SCHIMEL, J.P.[1], MELACK, J.M.[1], and SICKMAN, J.O.[2] Response of soil microbial N dynamics to fall rewetting events in a California chaparral community. [1]University of California, Santa Barbara, CA, and [2]Department of Water Resources, Sacramento, CA.

Nitrogen export from chaparral communities of the southern Sierra Nevada foothills is characterized by episodic NO_3^- losses during late-season rain events. We examined soil nitrogen (N) dynamics within a chamise-dominated community to characterize variation in soil inorganic N pools and microbial biomass during the transition from summer drought to fall/winter rains. Net nitrification increased over the course of the summer, ultimately exceeding net N mineralization. Microbial biomass decreased 50% during this period, while exchangeable NO_3^- concentrations remained stable (approx. 0.5 $\mu g\ g^{-1}$) and exchangeable NH_4^+ increased 4-fold. With the first rainfall event, NH_4^+ concentrations decreased 30%, while NO_3^- increased 30-fold, indicating a period of intense nitrifier activity following rewetting. Following the first large storm in which we had measurable discharge, soil NO_3^- concentrations decreased to pre-existing levels, and net N mineralization again dominated the system. These results indicate that nitrifiers may be competitive only during periods of initial rewetting, but that they may have a disproportionate impact on N losses from a system.

MILLER, R.M., CHAUDHARY, V., GADES, L., JASTROW, J.D., KIRK, S., MATAMALA, R., and SKOGEN, K.A.. Is there a mycorrhizal fungal response to CO_2 fumigation in the field? Environmental Research Division, Argonne National Laboratory, Argonne, IL.

Although plants grown under enhanced carbon dioxide (eCO_2) conditions have demonstrated that biomass allocation favors root growth at the expense of shoots, data on the responses of the mycorrhizal association to eCO_2 are few, especially for studies conducted in the field. Published studies indicate a range of observed responses from increased amounts of fungal growth to no clear effects. Furthermore, few of these studies have been conducted under Free Air CO_2 Enrichment (FACE) growing conditions. We present data on a series of separate experiments from *e*CO_2 fumigation studies that utilized open-top chambers (tallgrass prairie site in Kansas [KSU] and an Aspen and Maple site in Michigan [UMBS]) and FACE facilities (Sweetgum FACE site at Oak Ridge National Laboratory [ORNL] and SoyFACE near Champaign [UIUC]). The host species evaluated were *Andropogon gerardii*, *Populus trimuloides*, *Acer saccharum*, *Liquidambar styraciflua*, and *Glycine max*. A surprising outcome of these studies was the similarity in response of the mycorrhizal fungi to fumigation where these fungi appear to be responding to the increased root production associated with the fumigation treatment, i.e., no treatment effect for CO_2 fumigation was evident for the proportion of root length colonized by these fungi, regardless of site or host differences. However, because of the dramatic increases in root length associated with *e*CO_2, the mycorrhizal fungal colonized length of roots increased, regardless of site or species evaluated.

MORAN, K.K.[1], SIX, J.[1], HORWATH, W.R.[1], VAN GROENIGEN, J.W.[2], and VAN KESSEL, C.[1] **The role of inorganic N-fertilization in crop residue decomposition and soil organic matter formation in agricultural soil.** **[1]University of California, Davis, CA, and [2]Alterra, Wageningen, the Netherlands**

Agricultural ecosystems have an advantage over pristine natural systems in their potential for extra C sequestration because they are intensively managed, therefore strategies can be implemented relatively easily to maximize their C sequestration potential. In agroecosystems, inorganic N fertilizer not only increases crop biomass but contributes greatly to the available soil N pool. Many nutrient cycling models for agroecosystems assume that crop residue decomposition is controlled by the C to N ratio; therefore residue-C and –N are considered closely linked. A study was conducted to determine (1) if the impact of fertilizer-N on cycling of C and N through the microbial biomass is affected by residue quality, and (2) whether residue-C and residue-N are linked when accumulated by the microbial biomass in the presence of fertilizer-N. In a 40-day incubation the dilution of ^{13}C and ^{15}N in labeled microbial biomass was followed when one of these combinations of urea fertilizer and rice residue was added: no additions (control), urea only (control), low C:N residue (45:1), mid C:N (62:1), high C:N (99:1), low C:N + urea, mid C:N + urea, and high C:N + urea. Soil respiration was measured during the incubation and the microbial biomass analyzed at the start of the incubation and after 40 days. Fertilizer-N increased soil respiration regardless of residue quality, and microbial respiration increased with residue addition in the order Low C:N > Mid C:N > High C:N on a g^{-1} C added basis. Carbon and N movement through the microbial biomass suggested that residue-C and residue-N were not linked through the decomposition pathway. The linkage between residue-C and residue-N appears to be weakened in the presence of fertilizer N, and no interaction was observed between residue quality and fertilizer addition on soil respiration or microbial biomass growth or cycling. As microbial C and N are important precursors in the formation of stable SOM, the decoupling of the C and N may suggest a direct role of fertilizer N in the sequestration of C. We hypothesize that fertilizer-N contributes more than residue-N to the N sequestered in soil organic matter. Work is in progress to conduct a 90-day incubation of N-fertilizer and rice straw residue, amended to rice soil alone or in combination, that will be used to address our hypothesis. Labeled ^{15}N-fertilizer and rice straw residue with ^{13}C and ^{15}N will be used in separate treatments. Mineralization rates of ^{15}N and ^{13}C, as well as changes in microbial biomass ^{15}N and ^{13}C will be assessed during the incubation. Changes in the size and isotopic concentration of the humic, fulvic, and humin soil organic matter fractions will be analyzed at the end of 90 days to quantify the contributions of residue-N and fertilizer-N to potentially stable SOM pools.

MORRIS, B.[1], GREEN, C.[2], SAN FRANCISCO, M.[2], ZARTMAN, R.[2], and ZAK, J.[1] Impacts of Ricin on Soil Microbial Activity. [1]Department of Biological Sciences, and [2]Department of Plant and Soil Sciences, Texas Tech University, Lubbock, TX.

Ricin is a category B biological agent as listed by the Center for Disease Control and Prevention. The toxin is known to enzymatically attack the 28S ribosomal subunit and prevent protein synthesis. Ricin is a natural byproduct of castor oil production, is easy to obtain in large quantities, and is readily available. As part of a multidisciplinary study to examine the impacts of biological agents on agricultural systems, we have been examining the impacts of ricin on soil microbial activity. The first phase of this experiment was conducted under greenhouse conditions. Four treatments consisting of known amounts of ground castor bean were added to soil previously under cotton production. Ricin was applied at a concentration of 31.2 mg pot^{-1} dissolved in 28 ml of water. After ricin application, the soil was monitored for changes in microbial respiration, and microbial biomass. Treatments consisted of a soil control, a soil control plus sorghum, soil with ricin, and soil with ricin plus sorghum. Five replicate one-gallon pots were established for each treatment and soil respiration was taken every two days for the first week after ricin application, and continued weekly for three months thereafter. At two weeks, one, two, and three months after application, microbial biomass and microbial functional diversity in soil with and without ricin was evaluated. The treatments containing the biological agent saw a nine-fold increase in microbial respiration rates ($g/CO_2/m^2/hr$) initially, and an increase in microbial biomass of 100-120 $\mu g\ C\ g^{-1}$ soil. Changes in microbial biomass were not immediate, but occurred after 1 month following ricin application and increased throughout the first phase of the experiment. Microbial functional diversity also increased two weeks after ricin application and continually showed greater diversity versus the control pots. Collectively, these results suggest that ricin application to agricultural soils may have a stimulatory impact rather than a detrimental effect.

MOSER, A.M., PETERSEN, C.A., TUGAW, H., BERNINGHAUSEN, H.K., and SOUTHWORTH, D. Oak mycorrhizae on serpentine soils. Southern Oregon University, Ashland, OR.

We investigated diversity of ectomycorrhizal fungi associated with *Quercus garryana* to use as baseline data in categorizing the below-ground mycorrhizal community in diverse habitats. Our primary site was the Whetstone Savanna Preserve, a property of The Nature Conservancy and part of the Agate desert in southwest Oregon. The Agate Desert is an alluvial fan capped with a shallow layer of clay loam over cemented hard pan and is characterized by patterned ground with mounds and vernal pools. The landform is not true desert as it receives 48 cm of precipitation annually. The primary method used for analyzing diversity was morphotyping—describing mycorrhizae by a set of standard definitions. In addition molecular techniques were used to validate the distinctions among morphotypes, to compare mycorrhizal root tips to fungal fruiting bodies for purposes of identification, and to sequence portions of fungal DNA to identify mycorrhizal fungi through the use of DNA databases. Thirty-six ectomycorrhizal morphotypes were described and entered into a database. Five ectomycorrhizal morphotypes were found in 5% or more of soil samples. *Cenococcum geophilum,* the most abundant morphotype, was found in 75% of soil cores. At least four morphotypes are from hypogeous Ascomycetes. We then sampled oak roots in serpentine soils in southwest Oregon. Ectomycorrhizal diversity was greater on oak roots in serpentine soils than at the Whetstone site suggesting that lack of fertility in the serpentine soils promotes mycorrhizal formation and that the heavy metals in serpentine soils do not inhibit mycorrhizal growth. This research was funded by National Science Foundation Grant DEB-9981337 through the Biocomplexity Program and Research at Undergraduate Institutions.

NAGEL, J.M., TISSUE, D.T., and ZAK, J.C. Physiological responses to changes in soil properties: Potential impacts on desert plant communities in Big Bend National Park. Department of Biological Sciences, Texas Tech University, Lubbock, TX.

Globally, anthropogenic emissions of CO_2 and other greenhouse gases are likely to trigger a 1.5° to 3° C increase in average temperatures by 2100. This warming is expected to alter regional weather patterns, including precipitation regimes. Concurrently, increased fossil fuel and fertilizer use is expected to lead to increased atmospheric deposition of inorganic nitrogen. Resultant changes in soil moisture and nitrogen fertilization are likely to significantly impact plant community-level properties, including biodiversity and productivity. In Big Bend National Park (BBNP), in particular, climate models forecast increases in winter and summer precipitation by as much as 25%, and a dramatic increase in air pollution already has been documented. Because arid ecosystems have been predicted to be highly responsive to such changes, understanding plant community-level responses is especially important in these settings. These community-level responses will be influenced by the differential physiological responses of constituent species to changes in soil moisture, nitrogen fertilization and microbial responses. Because plant growth requires energy, it has been suggested that the most successful plant species in a given community are those that maximize energetic gains while minimizing energetic costs. Here, we describe a three-year project funded by the National Parks Ecological Research Fellowship Program designed to examine the influence of energetic processes on desert plant communities and the impact of changes in soil properties on these processes in BBNP. We will survey plant species' abundance and productivity and measure their energetic gains and costs in control, water-treated and nitrogen-treated plots within three distinct plant communities—lowland scrub (793 m), sotol-grassland (1526 m) and oak-pine forest (2098 m)—along an elevational gradient in the Pine Canyon Watershed. Our findings will allow us to elucidate how the physiological responses of energetic processes to changes in soil properties could influence desert plant communities now and in the future.

NAGY, A.[1], ROBERTSON, T.[1], WALKER, E.[1], LOIK, M.[2], TISSUE, D.[1], and ZAK, J.[1] Simulated Precipitation on Soil Microbial Processes and Nitrogen Dynamics in an Arid Ecosystem. [1]Texas Tech University, Lubbock, TX, and [2]University of California, Santa Cruz, CA.

Global climate change models have predicted a 25% increase in precipitation for the Chihuahuan Desert of the southwestern United States. The potential impacts of changes in the pattern and magnitude of precipitation on soil microbial and nitrogen dynamics in the Chihuahuan Desert are not well understood. The goals of this experiment are to address these issues. A multi-year study was initiated as part of the long-term monitoring effort at Big Bend National Park to examine the effects of simulated precipitation on soil microbial processes and explore the changes in nitrogen dynamics as a result of increased precipitation. The study was initiated in April 2001 in the Sotol Grasslands of Pine Canyon, B.B.N.P. Treatments include increased summer watering, winter watering, and summer and winter watering by 25% above current precipitation. Water was first applied to the plots in winter, 2002 and summer application occurring in August and September 2002. Two types of plots were established at the site. One plot contained either Sotol, brown spined prickly pear cacti, or grama grass within a 1x1.5m border pounded into the soil around the plant. These plots will be used to measure whole system gas exchange. The second type of plots was 3x3m and contained all dominant plant types. Within each plot type, soil extractable NO3-N, NH4-N, pH, and microbial biomass are measured every two months to examine the long-term impacts of changes in precipitation amounts and season. Preliminary results indicate that in grama grass, soil microbial biomass production decreased as a result of summer watering, while soil microbial biomass production increased after winter watering. Increased summer and winter watering for grama grass showed no trend in soil microbial biomass production. Sotol showed a decline in microbial biomass after summer watering treatments, and an increase in soil microbial biomass after winter watering treatments. Prickly pear cacti showed no trend in soil microbial biomass production as a result of watering. Nitrogen mineralization rates for all dominant plants showed no response to watering, however there appeared to be a seasonal trend with mineralization rates in all plots being the highest in the spring. In the 3x3m plots, summer watering appeared to have a slight impact on the production of soil microbial biomass. Mineralization rates in the large plots showed no response to watering, however, the amount of mineralization also appeared to be seasonal. Impacts of changes in precipitation on soil microbial activity may be related to indirect impacts on dominant vegetation rather than on microbes directly.

NEWMAN, G. S.[1], HART, S. C.[1], GUIDO, D. R.[1], and OVERBY, S. T.[2] **Wildfire effects on soil microbial activity and community-level physiological profiles in a ponderosa pine ecosystem.** **[1]School of Forestry and Merriam-Powell Center for Environmental Research, Northern Arizona University, Flagstaff, AZ, and [2]Rocky Mountain Research Station, USFS, Flagstaff, AZ.**
Forests of the western United States have received increasing incidence and extent of wildfire during the past decade as a result of increased tree densities and buildup of forest floor fuels due to fire suppression policies. Evidence of the direct effects of wildfire on soil microbial activity and composition is scarce and these effects may have a greater influence than prescribed burns due to the greater intensity of disturbance. Ponderosa pine plots in New Mexico associated with the national Fire - Fire Surrogate network were burned by wildfire in September 2002 following pretreatment measurements and prior to the initiation of treatments. We resampled these plots one month following the wildfire and one year following pretreatment measurements, removing any seasonal influence on soil activity. Wildfire homogenized bacterial community-level physiological profiles (CLPPs) and had the opposite effect on fungal populations. The bacterial CLPP plate activity doubled following wildfire while there was no effect on fungal plate activity. Conversely, basal and substrate-induce respiration were substantially lower than in a nearby unburned stand which was similar to the wildfire stand based on pretreatment measurements. Although β-glucosidase activity declined following wildfire, galactase, xylosidase, cellobiohydrolase, alkaline phosphatase, and sulfatase activities all increased significantly, consistent with the amplified bacterial metabolism observed in CLPPs. Wildfire and subsequent microbial activity resulted in 23x increase in net N mineralization, an 80% decline in net nitrification, and nearly 2x and 19x increases in soil available NO_3^- and NH_4^+ pools, respectively. Altered soil microclimate and organic matter transformations, as well as the removal of plant competition, following wildfire create a more favorable environment for microbial populations, which may facilitate the regeneration of forest stands through increased mineralization of plant available nutrients.

OBA, H.[1,2], SHINOZAKI, N.[3], OYAIZU, H.[3], TAWARAYA, K.[1], WAGATSUMA, T.[1], BARRAQUIO, W.L.[4], and SAITO, M.[5] **Arbuscular mycorrhizal fungal flora associated with some pioneer plants in lahar area of Mt. Pinatubo, Philippines.** **[1]Yamagata University, Tsuruoka, Japan, [2]Yokohama National University, Yokohama, Japan, [3]Global Agriculture Department, University of Tokyo, Tokyo, Japan, [4]Department of Biology, University of Philippines, Los Baños, Philippines, and [5]National Institute for Agro-Environmental Sciences, Tsukuba, Japan.**
The violent eruption of Mt. Pinatubo, Philippines in 1991, deposited very huge amounts of pyroclastic materials on and around the mountain. The deposited materials have eroded as lahar during rainy season and have buried an extensive area. In 1999, we examined the arbuscular mycorrhizal fungi (AMF) in the lahar area. In the experimental site in Pampanga, Philippines, most of the area was sparsely vegetated with only a few gramineous plants, *Saccharum spontaneum* and *Rhynchelytrum repens*. However, some densely vegetated areas could be found in patches. These

patches were characterized by co-existence of the gramineous and leguminous plants such as *Calopogonium muconoides*. Growth of the gramineous plants in these patches was greatly favored. In both less and densely vegetated areas, high densities of AMF spores were found. *S. spontaneum* was slightly colonized with AMF while the leguminous plants were highly colonized. Spores of AMF were collected from the rhizosphere of these plants. Some AMF were propagated by trap culture. Based upon spore morphology, the AMF spores were classified into 8 taxa: one *Acaulospora* sp., *Entrophospora colombiana*, two *Glomus* spp., one *Paraglomus* sp. and three *Scutellospora* spp. A part of 18S rRNA gene of AMF colonizing the plant roots was amplified with AMF specific primers, AM1 and NS31, cloned and sequenced. Fifty-three AMF clones were obtained. Phylogenetic analysis showed that these belonged to 8 taxa: one *Acaulospora* sp., *Entrophospora colombiana*, five *Glomus* spp. and one *Scutellospora* sp. *E. colombiana* was only detected from the roots or rhizosphere of *C. mucynoides* in densely vegetated sites, while most AMF taxa were detected from both the sparse and dense sites. The influence of AMF on the primary plant succession in the lahar area will be discussed.

O'BRIEN, S.L.[1], JASTROW, J.D.[1], PREGITZER, K.S.[2], and ZAK, D.R.[3] Effect of soil fertility on physically fractionated soil C and N pools of sandy soils exposed to elevated atmospheric CO_2. [1]Argonne National Laboratory, Argonne, IL, [2]Michigan Technological University, Houghton, MI, and [3]University of Michigan, Ann Arbor, MI.

The effects of rising atmospheric CO_2 on soil organic matter will depend on many factors including changes in plant inputs, soil capacity to protect organic matter from decomposition, and nutrient availability. We used physical fractionation techniques to evaluate soil C and N pools at the conclusion of a two-year, open-top chamber study comparing the responses to CO_2 enrichment of aspen and maple saplings grown on sandy soils with contrasting fertility levels. In the high fertility soil, we saw trends suggesting that soil C and N might decrease under elevated CO_2 for aspen but might increase for maple, which is slower-growing and more shade tolerant. In the low fertility soil, however, we found significantly lower C and N in coarse particulate organic matter (POM), fine POM, and the silt-sized fraction for both species. In addition, the C:N ratio of coarse POM increased under elevated CO_2. These results suggest that increased plant/microbial demand for N and/or increased availability of C to soil microbes under elevated CO_2 conditions may stimulate mineralization of the relatively unprotected organic matter of these sandy soils, particularly when nutrients are limiting.

OJALVO-MAYZLISH, E. and STEINBERGER, Y. Effects of inhibitors on the dynamics of the protozoa population in a desert soil ecosystem. Life Sciences Faculty, Bar Ilan University Ramat Gan, Israel.

The protozoa population belongs to the microfauna component of the soil and plays a major role in the recycling of soil nutrients. The aim of this study was to monitor the composition, size and dynamics of the protozoa population during the different seasons as well as to examine their contribution to the ecological system using selective chemical inhibitors.

Soil samples were collected from the research area at Avdat in the Negev. The samples were collected from the 0-10 cm depth and from 10-20 cm depth, from four different treatment plots: Nemacur as a nematocide, Edigan as a biocide, water and control as not treated plot. In addition to the field experiment, a parallel experiment was conducted under controlled conditions in the Bar-Ilan University greenhouse, with a similar treatment as the field experiment.

The results obtained from the field study demonstrated that the water content of the soil was affected by the rain events that occurred during the rainy season. This change resulted in a positive response, i.e. in an increase in the biological activity. It was also found that the number of protozoa individuals was significantly higher in the soil as spring neared. The flagellates group appeared in the soil samples during the entire year, whereas the ciliate population appeared mainly during the moist seasons. During the spring, significant changes between treatments occurred in the composition and size of the protozoa population. In the controlled experiment (the greenhouse experiment) significant differences were found in the composition and size of the protozoa population between the experimental and the control containers and between the different sampling periods. These results indicate the inhibitors influence on size, and dynamics of the protozoa population and their contribution to the food soil web and nutrients flow.

PARKER, S.S. and J.P. SCHIMEL. Nitrogen transformations in native perennial and exotic annual grasslands in California. University of California, Santa Barbara, CA.
Given that nitrogen is the most common limiting nutrient in California grassland soils, and that the introduction of even a single plant species can have large effects on nitrogen cycling in an ecosystem, the invasion of native perennial bunchgrass communities by exotic species of annual grasses from Europe raises many questions regarding the processing and retention of nitrogen in these systems. We have employed a mechanistic approach to understanding these changes by using experimental grassland plots with homogeneous initial soils. Plots were seeded with a mix of either native perennial grasses (*Nassella pulchra*, *Bromus carinatus*, and *Elymus glaucus*) or nonnative annuals (*Bromus hordeaceus*, *Bromus madritensis*, and *Hordeum murinum*). We quantified leaching losses of nitrate, ammonium, and dissolved organic nitrogen, and measured rates of microbial nitrogen transformations (mineralization, nitrification, and denitrification) to examine the relative importance of these different processes in contributing to nitrogen loss from each grassland type. Nitrogen fertilization was used as a tool to better understand process interactions. Exotic annual grass stands may be somewhat more "leaky" with regard to nitrogen than stands of native perennial grasses. Seasonal trends in microbial process rates that correspond with soil moisture indicate that rates of nitrification and denitrification, as well as leaching losses, are controlled by rainfall, or the lack thereof. In dry years, low soil moisture may be more important than species composition in determining nitrogen losses from grasslands, while the differences in plant phenology and microbial process rates in annual and perennial grassland soils may be more important in wetter years.

PAVAO-ZUCKERMAN, M.A. and COLEMAN, D.C. Response of the forest soil nematode community to an urban environment. Institute of Ecology, University of Georgia, Athens, GA
Urban ecology answers the need to understand the environmental implications of global trends in urbanization, as well as the recognized need to include humans as components of ecosystems. The data presented here are part of a study conducted to investigate the effects of urban land-use on ecosystem processes in Asheville, NC. This research is being conducted using a framework for ecological studies along urban-rural gradients. This framework accounts for the interacting effects of urbanization on the physical-chemical environment, soil biota, and ecosystems. The objectives of this study are to determine the response of the soil nematode community to urbanization, and the ecosystem consequences of this response. Forested research plots were established along a transect running from downtown Asheville, NC, to the Pisgah National Forest to the southwest. The nematode community of these forested soils were extracted and identified. Ecological measures of diversity, community composition, maturity, and food web status are calculated for the forest plots along the urban to rural transect. The urban soils tend to have food web pathways exhibiting much less fungal dominance than the rural soils. Results presented here suggest that soil nematode community trophic composition, rather than diversity indices, respond to urban land-use along the gradient. These results are discussed within the context of soil quality, and ecosystem processes such as leaf litter decomposition and nutrient cycling. This investigation of urban soil ecology suggests that even in relatively small cities, such as Asheville, NC, urbanization can have important environmental consequences for the structure and function of soil ecosystems.

PEN-MOURATOV, S. and STEINBERGER, Y. Pesticides effect on soil free living nematode community structure and diversity. Faculty of Life Sciences, Bar Ilan University, Ramat Gan, Israel

Structure and diversity of soil free living nematodes community as response to nematocide and biocide in a desert soil ecosystem was studied. Soil samples were collected from the 0-10 cm depth and from 10-20 cm depth, between November 2000 and November 2001. The samples were collected monthly from plots treated by: (a) Nemacur (nematocide); (b) Edigan (biocide); (c) water and (d) no treated plots (control).

Total free-living soil nematodes in the control as well in the water treatment was found to be significantly higher during most of the year, reaching mean values between 100 and 250 individuals 100 g^{-1}, except during the cold winter months of January and February, when the population size was found to be similar in all samples.

The results obtained demonstrated that the water content of the soil was affected by the rain events that occurred during the rainy season. Nematode communities, as well as spatial distribution found to be affected by treatments on a temporal basis. The different treatments applied led to a significant difference in the abundance of trophic groups, where the fungivores and bacterivores were found to decrease in the pesticide-treated samples. A total of 31 genera were found, with 21 in the Nemacur-treated plots and 16 in the Edigan-treated plots. The results had elucidated the negative effects of pesticide on temporal and spatial basis on soil nematode community structure and trophic composition.

PETT-RIDGE, J., SILVER, W.L., and FIRESTONE, M.K. The effects of oxic/anoxic fluctuation on microbial communities and nitrogen cycling in a wet tropical soil. University of California, Berkeley, CA.

Oxygen is the primary terminal electron acceptor for most soil organisms respiratory processes; its presence is a critical determinant of both soil redox status and the physiological pathways available to microbial nutrient cyclers. To determine effects of fluctuating redox on N processing, we have used both lab and field isotope additions, followed by measurement of all potential ^{15}N pools including: NO_3, NH_4, microbial biomass, N_2 and N_2O. We attempt to correlate these process rates with microbial community fingerprints generated by TRFLP (Terminal Restriction Fragment Length Polymorphism) analysis.

The results of this work suggest than in these variable redox soils, microbial biomass is maintained by redox fluctuation and diminished by static oxic or anoxic regimes. Gross N mineralization was relatively insensitive to soil O_2 availability and remained fairly constant over the course of the experiments. In contrast, gross nitrification rates were extremely sensitive to low redox conditions, yet nitrification does re-occur when O_2 becomes re-available. Dissimilatory nitrate reduction to ammonium (DNRA) occurred in nearly all treatments over the course of the experiments, and relative to denitrification, was the more significant fate for NO_3 in these soils. DNRA was promoted by both low redox and fluctuating redox conditions, and was unaffected by brief O_2 exposure. These results suggest that redox fluctuation in tropical soils may encourage N retention through the co-occurrence of nitrification and rapid DNRA.

Microbial community TRFLF fingerprints were strongly influenced by static versus variable redox regimes. Communities that experienced lab oxic/anoxic fluctuations on a 4 day time-scale appeared most similar to field communities, whereas those that incubated under more consistently anaerobic regimes, developed distinctly different TRFLP profiles. Our results suggest that the microbes that process N in such variable redox soils may be more tolerant of redox shifts than commonly thought possible.

PREISSER, E.L., and STRONG, D.R. Biotic and abiotic control of an underground trophic cascade. Center for Population Biology, University of California, Davis, CA.
Plant vigor promoted by natural enemies of herbivores provides a powerful demonstration of food web dynamics. While climate affects both herbivores and plants, we know little about its role in regulating tritrophic interactions. We demonstrate that variation in rainfall linked to the El Niño/Southern Oscillation (ENSO) cycle, through its effect on soil moisture, impacts predators (the entomopathogenic nematode *Heterorhabditis marelatus*) more strongly than either herbivores (root-feeding larvae of the ghost moth *Hepialus californicus*) or their host plants (the bush lupine *Lupinus arboreus*). ENSO effects thus modulate this powerful trophic cascade. We performed a two-year field experiment on lupine bushes, with a two-factor crossed design: predator (nematode added) or no predator, versus water (supplemental water) or no water. Watering simulated the soil moisture conditions of wet summers that occur irregularly due to heavy winter/spring rains produced by ENSO climatic events. The predator treatment tested whether the nematode was capable of inducing a trophic cascade, while the water treatment tested whether rainfall directly affected the species in the cascade; the interaction of the two effects tested whether the indirect effects in the cascade are influenced by ENSO variation. During the first year, the predator decreased caterpillar abundance and indirectly increased lupine growth and seed set, while watering did not affect either species. During the second year, a natural outbreak of ghost moths increased herbivore densities 16-fold over the previous year. When confronted with this herbivore outbreak, predatory nematodes were capable of protecting lupines throughout the year only in the wet ENSO soils. The predator/water treatment decreased herbivore abundance in plant roots by 42%, and increased lupine growth by 54% and seed set by 44%. This suggests that the periodic large-scale lupine die-offs linked to underground herbivory, and the nematode-ghost moth-lupine cascade, are affected by climatic variation.

PRITEKEL, C.M.[1], WHITTEMORE-OLSON, A.A.[1], FENSTEMAKER, H.[2], MONTANO, S.[3], RIVAS, T.[2], SNOW, N.[1], and MOORE, J.C.[1,2] Impacts from the use of herbicides on the plant community and below ground ecosystem at Rocky Mountain National Park, USA. [1]Biological Sciences, [2]Math and Science Teaching (MAST) Institute, and [3]Frontiers in Science Institute, University of Northern Colorado, Greeley, CO.
The objective of this study is to assess the effects of changes in the plant community and below ground soil ecosystem from the invasion of leafy spurge (*Euphorbia esula L.*) and Canada thistle (*Cirsium arvense L.*), and the subsequent use of herbicides. The above and below ground ecosystem compartments are linked via energy input, decomposition and nutrient mineralization/immobilization. Changes in the composition of one compartment can influence the abundance and diversity of species in the other. Three paired sites containing areas where herbicides have been applied and which are still dominated by leafy spurge, and areas where herbicides have not been applied were sampled. Plant species diversity, frequency and percent cover was estimated. Decomposition rates were assessed by use of litterbags placed on the sites. Vesicular-arbuscular mycorrhizal inoculum potential, which was used as an index for mutualistic associations, was determined. Soil arthropod densities and diversity, which were used as an index for the detrital food web, were determined by extraction from soil samples and identified to genus. Results from summer 2001 and fall 2001 found significantly higher ($p < .05$) richness of plant species and percent relative cover of forbs, sedges and fallen litter on native sites where herbicides have not been applied. Adjacent sites where herbicides have been applied possessed a significantly higher percentage of bare ground. Mycorrhizal inoculum potential did not differ between sites. Overall arthropod and mite densities were significantly lower ($p < .05$) in herbicide treated sites. These results indicate that a shift in the plant community and in the soil arthropod community has occurred due to disturbance from either the leafy spurge infestation, herbicide application or a combination of both disturbances.

QUEREJETA, I.[1], EGERTON-WARBURTON, L.[2], LINDAHL, A.[1], and ALLEN, M.F.[1]
Differential access to groundwater and hydraulic lift determine tree mycorrhizal status during prolonged drought in a Southern California oak woodland. **[1]Center for Conservation Biology, University of California, Riverside, CA, and [2]Conservation Science Department, Chicago Botanical Gardens, Glencoe, IL.**
We examined the mycorrhizal status of mature coast live oak (Quercus agrifolia) trees growing at two neighboring sites with constrasting water availability during a two year period characterized by severe drought conditions. Trees in the xeric hill site showed increasingly negative predawn xylem water potentials during the long rainless summer period, whereas oaks in the mesic valley bottom site with access to groundwater maintained similarly high predawn xylem water potentials all year round. Soil water potentials and H and O stable isotope measurements in tree rhizospheres showed that valley oaks were able to keep the upper soil layers (0-50 cm deep) relatively wet during prolonged drought through hydraulic redistribution. EM percentage colonization of roots, morphotype richness and rhizosphere soil hyphal density were significantly higher in valley than in hill trees during drought. Hill trees showed a very dry rhizosphere soil, high levels of EM fine root senescence and higher
proportion of roots colonized by AM fungi. These results suggest that access to groundwater and hydraulic lift allowed valley oaks to maintain the integrity of their ectomycorrhizal associations in the upper soil even during prolonged drought.

QUIRK, M.[1], KING, J.[3], MILCHUNAS, D.[2,4], MOSIER, A.[2,4], PRITEKEL, C.[1], and MOORE, J.[1] **Initial Impacts of Altered UVB radiation on below ground food web interactions in Shortgrass Steppe.** **[1]Department of Biological Sciences, University of Northern Colorado, Greeley, CO, [2]Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO, [3]Department of Ecology, Evolution and Behavior, and Department of Soil, Water and Climate, University of Minnesota, St Paul, MN, and [4]USDA-Agricultural Research Service, Soil-Plant-Nutrient Research Unit, Fort Collins, CO.**
A study was initiated in spring of 2001 in the Colorado shortgrass steppe to identify the effects of two different components of climate change; UV-B radiation and CO_2 on below ground food webs. Interactions between UV radiation and elevated CO_2 have very seldom been studied. In the field, open-air structures were constructed of solid plastic sheet material that either passed all wavelengths of solar radiation or passed all wavelengths except for UV-B (280-315 nm). Litterbags containing plant tissue grown under different CO_2 conditions were placed under some of the structures to monitor decomposition and soil fauna. Precipitation under all structures was applied by manual watering, and two levels were maintained to simulate high precipitation or drought conditions. Preliminary results indicate that the density of litter arthropods was higher under reduced UV-B radiation conditions. Exclusion of UV resulted in nearly twice as many total arthropods as the ambient UV treatment. Wet-year conditions also resulted in nearly twice as many arthropods as compared to drought conditions. Prostigmata and root feeding insects were significantly affected by the exclusion of UV-B radiation whereas detritivorous Cryptostigmata and predaceous Mesostigmata were unaffected. There was no effect on total arthropod numbers from elevated or ambient ($C0_2$) litter source. After two field seasons, there was no significant effects of UV, CO_2, or wet/dry treatments observed for counts of fungal hyphae.

REED, H.R. and SEASTEDT, T.R. When a C4 grass species invades a C4 grassland, does it change soil processes? Case of *Andropogon bladhii* vs. *Andropgon gerardii*. University of Colorado, Boulder, CO.

Many ecosystem processes can be altered by plant species invasions. However, much of our understanding of these ecosystem alterations stem from invasions of plant species that are drastically different from the dominant, native vegetation type. A contrasting invasion scenario is occurring at the Konza tallgrass prairie Long-Term Ecological Research site: an exotic C4 grass species is establishing within the resident C4 grassland. To examine whether the invading C4 grass species, *Andropogon bladhii* and the dominant native C4 grass species, *Andropgon gerardii*, differ in their associated biogeochemical processes, we measured various soil processes and biogeochemical properties in areas dominated by each species. Although aboveground and root biomass are significantly greater for *A. bladhii* plants than *A. gerardii* plants, we found no significant differences for most of the biogeochemical parameters measured. Total soil C, N, and C:N ratio, microbial (fumigated) C, N, and C:N ratios, decomposition rates, potential C mineralization, potential net N mineralization were not significantly different beneath the two species ($p>0.05$). However, marginal trends suggest a decrease in nutrient cycling and greater immobilization of N in soil under A. *bladhii*. An effect of plant presence on soil processes was evident for most soil properties measured. We attribute this to the development of large areas of bare soil within sites dominated by the exotic, *A. bladhii*. The bare areas result in a decrease in nutrient cycling rates and a reduction of total C and N pools. The strength of the effect of plant presence within *A. bladhii* sites is dependent on burning with burning strengthening plant presence effects. Overall, *A. bladhii* has a small effect on soil processes, however, long term effects may be driven by the creation of relatively large areas of unvegetated, bare soil between individual plants decreasing soil resource availability. The strength of *A. bladhii*'s effect is likely to be influenced by the frequency of the natural disturbance regime that historically maintained tallgrass prairie.

RESINGER, J.S.[1], SIROTNAK, J.[2], and ZAK, J.C.[1] Microbial and Soil Nutrient Dynamics Associated with Degraded Grasslands in Big Bend National Park. [1]Texas Tech University, Lubbock, TX, and [2]Big Bend National Park, Big Bend National Park, TX.

Much of the original grasslands in Big Bend National Park and throughout the Big Bend Region of west Texas have undergone a considerable amount of degradation over the last 100 years. Within the National Park, a majority of the original lower desert grasslands have been reduced to patches or bands of grass within areas of bare ground or surrounded by shrubs. As part of a recent effort to evaluate the potential of reclaiming some of these previously grass-dominated landscapes in Big Bend National Park, we have begun to examine soil microbial and nitrogen dynamics in two degraded grassland sites within the park. Our goals are to understand how microbial and nitrogen dynamics differ between the stable grassland areas and those sites that have been degraded in order to provide basic information needed for revegetation efforts. Our two sites, the Airport and Dog Canyon sites are located in the northernmost part of Big Bend National Park. At these sites, soils consist of a deep silty loam and are classified as tornillo. Much of the dominant grass species at these two locations is Tabossa grass (*Hilaria mutica*). At each site soil samples are taken along 100 X 30 m transects in areas of bare soil and areas dominated by the native Tabossa grass. Microbial Biomass Carbon at both sites is two times higher in the grass areas than the bare areas. However, while levels of ammonia are higher at both sites for samples taken from grass dominated areas versus the degraded bare area samples, nitrate levels at the Airport site are significantly higher in the bare and fragmented areas. Revegetation success may be predicated on our understanding of the mechanism that regulates the linkage between microbial activity, nitrogen dynamics and hydrology in these arid systems.

Laelapidae characterized the more disturbed systems, whereas members of the families Veigaiidae and Zerconidae were less abundant, but were specifically present in the less disturbed systems. These results are in agreement with a previously proposed Maturity Index for mesostigmatid mites based on European taxa.

VUTURO, M. A., BOHRER, K. E., and FRIESE, C. F. The role of mycorrhizal fungi and seasonality in the functional restoration of wetland ecosystems. University of Dayton, Dayton, OH.

Arbuscular mycorrhizal fungi have recently been found to be abundant in wetland ecosystems. However, the functional role of mycorrhizae in wetland ecosystems is, at best, poorly understood. This study focuses on the seasonal dynamics of mycorrhizae in two fens and two marshes in Dayton, OH. Previous research at the selected sites found that the mycorrhizal colonization levels of plant species were most significantly affected by month, and not by edaphic factors, such as phosphorous or soil moisture. This indicated that the mycorrhizae were being controlled not by edaphic factors, but rather by plant phenology. Therefore, the seasonal dynamics of the mycorrhizae were influenced the greatest by the plant species present. These preliminary conclusions would suggest that arbuscular mycorrhizae have a functional role in wetland ecosystems that is not solely dependent upon the soil characteristics. New research is currently ongoing into the long-term seasonal dynamics of mycorrhizae to better understand the nature of the symbiosis in wetland ecosystems. This study is also investigating other parameters such as microbial diversity and activity within the same four wetland ecosystems over time. The long-term data generated from this research will provide a better understanding of the population dynamics of mycorrhizae and other microbes in wetland ecosystems, which in turn will improve our knowledge regarding the importance of these microorganisms as a factor in wetland restoration.

foliar herbivory

WARDLE, D.A. Belowground consequences of introduced browsing mammals in New Zealand rainforest. Swedish University of Agricultural Sciences, Umeå, Sweden, and Landcare Research, Lincoln, New Zealand.

Forest dwelling browsing mammals, notably feral deer and goats, have been introduced to New Zealand over the past 220 years; prior to this such mammals were absent from New Zealand. The New Zealand forested landscape therefore presents an almost unique opportunity to determine the ecological impacts of introduction of an entire functional group of alien animals to a habitat from which that group was previously absent. This presentation will consider the ecological consequences of introduced browsing mammals in New Zealand, with emphasis on the decomposer subsystem. To set the context, the mechanistic bases through which herbivores can indirectly affect decomposers (both positively and negatively) will first be briefly reviewed. The impacts of introduced browsing mammals in New Zealand forests will then be illustrated by a case study involving 30 natural rainforest locations throughout New Zealand; at each of these locations a fenced 20m x 20m exclusion plot was set up between 20 and 42 years ago. This work considers the impacts of browsing mammals on the functional composition of the vegetation, the consequences of this for the quality of litter entering the decomposer subsystem, and flow-through effects on the composition and diversity of the belowground biota as well as on the ecosystem-level processes that it carries out. The results of this work show that the introduction of browsing mammals to New Zealand has had far-ranging effects at both the community- and ecosystem-levels of resolution, with particularly adverse effects for both indigenous plant communities and populations of most litter-dwelling soil mesofauna and macrofauna.

Root productivity decreased w/ defoliation - increased exudation + therefore ↑ nematodes grazing

→ Separate habitat structure from litter quality

WEINTRAUB, M.N. and SCHIMEL, J.P. Soil amino acid dynamics in the Arctic tundra of Alaska. [1]University of California, Santa Barbara, Department of Ecology, Evolution, and Marine Biology, Santa Barbara, CA.

Previous research has left us with the conclusion that organic N uptake by plants may be important in tundra ecosystems, but we are still unsure just how important amino acids are in these soils. Our understanding of the role of organic N in the tundra is limited by a lack of knowledge of soil amino acid dynamics. To assess amino acid availability in tussock, shrub, and wet meadow tundra soils we measured amino acid concentrations throughout the 2000 growing season; we used an isotopic labeling approach to quantify the turnover dynamics of a range of amino acids; and we measured both actual and potential rates of protease activity to determine the controls on amino acid production by exoenzymes. Total amino acid concentrations were usually higher than concentrations of NH_4^+ in the same extracts. Most amino acid concentrations were highest in tussock tundra and lowest in shrub tundra. Amino acid concentrations in all soils dropped to barely detectable levels in the middle of July, suggesting intense competition for this N resource at the height of the growing season. In general, the acidic amino acids, aspartic acid and glutamic acid, had the highest rates of turnover of any of the amino acids in our study, while the basic amino acids arginine and lysine typically had the lowest rates of turnover. Turnover rates of the neutral amino acids in our study, glycine and serine, were variable, encompassing the range of measured values. Protease activity rates were also variable, but were always higher with added substrate, indicating that amino acid production by protease is limited by substrate availability more than enzyme activity.

WAHEED, T.[1], WHALEN, J.K.[1], and SAMPEDRO, L.[2] Quantifying surface and subsurface cast production by *Aporrectodea rosea* (Savigny) and *Lumbricus terrestris* L. under controlled conditions. [1]McGill University, Ste-Anne-de-Bellevue, QC, Canada, and [2]Universidade de Vigo, Vigo, Galicia, Spain.

Earthworm populations in temperate ecosystems of North America may produce 10 Mg ha^{-1} or more of casts each year. Under laboratory conditions, casts generally possess greater microbial activity, more available nutrients, and greater aggregate stability than bulk soil in the first few weeks after they are produced. These findings can not be extrapolated easily to the field. Casts are deposited throughout the soil profile, and those on the soil surface are exposed to more disruptive forces (wetting-drying, freezing-thawing) than casts deposited belowground. The purpose of this study was to quantify the proportion and rate of surface and subsurface cast production by *A. rosea* and *L. terrestris* at four soil temperatures (5°C, 10°C, 15°C and 20°C). Plexiglass chambers (450 mm x 450 mm) were adjusted to a width of 3 mm for *A. rosea* and 4.5 mm for *L. terrestris*. Soil (<1 mm mesh) was placed into each chamber, and 11 g kg^{-1} of organic residues (40% corn residues and 60% composted cattle manure, ground <1 mm mesh) were mixed thoroughly with the soil in the top 150 mm of each chamber. The soil was moistened to 80% of field capacity through capillary action and pre-incubated for one week at 20°C. Two adults of *A. rosea* or *L. terrestris* were added to each chamber, and 5 replicate chambers were placed in controlled climate incubators set to 5°C, 10°C, 15°C and 20°C for one week. Surface and subsurface cast production was observed visually every 24 h, and casts were collected and weighed after one week. Our preliminary findings indicate that cast production is temperature dependant, and that the majority of casts produced by *A. rosea* and *L. terrestris* are deposited on the soil surface. The relevance of this work for estimating how earthworm casts contribute to nutrient cycling and aggregation under field conditions will be discussed.

narrow zones, as might be expected due to a lack of soil mixing under no-till. The measurements were made during the third year of no-till treatment, and stratification of total organic C and N was apparent. These measurements are ongoing, and my goal is to devise a strategy for discovering the physical and biological factors which result in such large differences in nitrogen dynamics. Possible additional measurements might be aeration and denitrification.

XU, B., SHARDA, J.N., and KOIDE, R.T. A comparison of ectomycorrhizal fungal communities based on root tips and soil hyphae. Pennsylvania State University, University Park, PA.
We compared two methods for assessing the structure of the ectomycorrhizal (ECM) fungal community in a red pine plantation. The first was the more conventional method based on collections of root tips. The second was a newer method based on the identification of hyphae in the soil. Our interest in the hyphae, as opposed to the root tips, stems from the important role played by the hyphae in resource acquisition, and by the fact that the hyphae of the various ECM fungal species may partition the forest floor in space and time differently than the root tips. Sampling in July, September and October of 2002 revealed that the community structures based on hyphae and root tips differed significantly. Species richness, evenness, and the relative abundances of individual species were significantly different.

YELENIK, S.G.[1], STOCK, W.D.[2], and RICHARDSON, D.M.[3] Ecosystem-level impacts and restoration implications of invasive *Acacia saligna* in the South African fynbos. [1]Department of Organismic Biology, Ecology, and Evolution, University of California, Los Angeles, CA; [2]Department of Botany, and [3]Institute for Plant Conservation, University of Cape Town, Rondebosch, South Africa.
Recent management efforts to clear alien plants from the fynbos vegetation type of South Africa forces managers to think about how N_2-fixing invasives have altered ecosystem processes and the implications of these changes for community development. This study investigated changes in fynbos N cycling regimes with the invasion of *Acacia saligna*, the effects of clear-cutting acacia stands on soil microclimate and N cycling, and how altered N resources affected the growth of a weedy grass species. Litterfall, litter quality, soil nutrient pools, and ion exchange resin (IER) available soil N were measured in uninvaded fynbos, intact acacia and cleared acacia stands. In addition, a bioassay experiment was used to ascertain whether the changes in soil nutrient availability associated with acacia would enhance the success of a weedy grass species. Acacia plots had greater amounts of litterfall, which had higher concentrations of nitrogen. This led to larger quantities of organic matter, total N, and IER available N in the soil. Clearing acacia stands caused changes in soil moisture and temperature, but did not result in differences in IER available N. The alteration of N availability by acacias was shown to increase growth rates of the weedy grass *Ehrharta calycina* suggesting that secondary invasions by nitrophilous weedy species may occur after clearing N_2-fixing alien species in the fynbos.

ZABORSKI, E. R. Earthworms, soil mites and litter decomposition as influenced by insecticide application and three years of Bt transgenic corn production. Center for Economic Entomology, Illinois Natural History Survey, Champaign, IL.
It is hoped that the introduction and widespread adoption of Bt transgenic crops engineered to express the insecticidal endotoxins of the bacteria *Bacillus thuringiensis* will significantly reduce the use of synthetic chemical insecticides in agricultural systems. However, concern have been voiced about the potential for unexpected environmental impacts resulting from such widespread adoption. A 3-yr replicated plot study was initiated in 2000 to investigate the potential influence of *Bt*

endotoxin (Cry1Ab, Cry9C and Cry3Bb) expression in corn plants on soil invertebrate communities and decomposition, and to compare this to the influence of a standard insecticide program for control of European corn borer (*Ostrinia nubilalis*) and corn rootworms (*Diabrotica* sp.). This poster expands on results presented previously for the first year of the experiment. Straw litterbags were used to assess the environmental influence on litter mass loss patterns through 2001 and 2002. Mass loss from transgenic and non-transgenic crop residues (leaves and stems) were placed in a non-transgenic, non-insecticide plot to isolate the influence of residue quality on mass loss patterns in 2001 and 2002. Microarthropods were extracted from all litterbags to document the succession of decomposers on decomposing residues. Earthworm populations were sampled by formalin expulsion in 2000 and 2001; in 2003, the AITC expulsion method was used. Results of litter bag decomposition experiments and earthworm population/community structure analyses will be presented and discussed.

ZAK, J. C.[1], SOBEK, E.[1], NAGY, A.[1], GRIZZLE, H.[1], and KRZYSIK, A.[2] Impacts of disturbance severity on microbial and nutrient dynamics in forested areas at Ft. Benning, GA: Implications to forest management. Texas Tech University, Lubbock, TX, and [2]Prescott College, Prescott, AZ.

Upland pine forests within the Ft. Benning GA Military Reservation represent a mosaic of military land use that overlays a prescribed fire regime that has been ongoing for the last forty years to maintain open forest conditions in some locations. As part of a multi-scaled effort to develop ecological indicator guilds to provide critical information for forest managers at the base, we have examined seasonal and yearly changes in soil microbial biomass, microbial functional diversity, and soil nutrient dynamics in nine sites within these upland pine forests. Our sites are located along a disturbance gradient (low medium and high) that reflects the types of military training use coupled with prescribed burning regimes. Sites have been sampled in May and November beginning in 2000. The sample dates were chosen to provide a measure of seasonality within these systems. At each sampling time, six composite soil samples are taken to 15 cm and sieved through a 2 mm sieve to remove roots and large amounts of organic matter. The lack of substantial differences in microbial biomass carbon among the Low and Medium impacted sites only in November has been a consistent theme over the last three years of sampling. These results indicate that at this time of year, when moisture is not limiting, microbial dynamics within the Low and Medium impacted sites are similar. Microbial activity in the High impacted locations is still severely constrained by disturbance even with increased moisture. The direction and magnitude of the microbial response is very much predicated on the seasonal pattern of moisture. Soil NO_3-N levels are highest in the Medium and High impact sites compared with the Low disturbed sites. The highest levels of NH_4-N are associated with the Medium disturbed sites. The lowest levels are associated with the Low disturbance locations. The pool sizes of NO_3-N and HN_4-N are very dependent upon plant uptake and soil moisture levels. The higher levels of NO_3-N in the Medium and High Disturbance sites reflect the level of disturbance from fire and military activity at these locations and the associated decline in plant uptake. NH_4-N levels among sites reflect differences in mineralization rates coupled with differences in plant and microbial uptake rates. Microbial functional diversity is highest in the Low disturbed locations during the dry portions of the year. As soil moisture increases in the fall, differences in functional capabilities of the soil microbes among the disturbed sites become less. Microbial response to disturbance and fire is influenced by seasonal variability in moisture inputs. Although vegetation structure may be comparable among locations, current microbial dynamics reflect long-term impacts of previous disturbances and current fire regimes.

ZHU, W.X. and FICKBOHM, S.S. Purple loosestrife (*Lythrum salicaria*) invasion of cattail (*Typha latifolia*) freshwater wetlands: changes beyond aboveground species replacement. Binghamton University – State University of New York, Binghamton, NY.

The ecological consequences of exotic plant invasion are frequently studied above-ground, focusing largely on the species interactions with native plants (competition) or animals (herbivory, habitat utilization, etc.). The consequences at the ecosystem level, especially on below-ground processes such as organic matter accumulation, soil nutrient transformations, hydrological fluctuation, and the effects on surface water chemistry, are less known. These alterations at the ecosystem level, however, set the context among which species interactions occur. We examined the alterations of ecosystem functions and explored the mechanisms involved when a freshwater cattail (*Typha latifolia*) wetland is invaded by an exotic emergent plant purple loosestrife (*Lythrum salicaria*). Investigations were conducted both in the field and in the greenhouse. Transects were set in Montezuma National Wildlife Refuge, NY, in the summer of 2001 that originated from pure *Typha* stands, crossed over mixed stands, and extended into pure *Lythrum* stands. There was significantly more standing dead biomass of *Lythrum* than *Typha* (1.88 vs. 0.59 kg m^{-2}); while collapsed dead *Typha* shoot forms a layer of litter which is absent in *Lythrum* stands. Soil organic matter content, however, was significantly higher in *Lythrum* sediment than in *Typha* sediment (18.0 vs. 14.7 kg m^{-2}, down to 20 cm deep). Soil net N mineralization was largely controlled by local hydrology, with rates more than doubled in August when the dropping water table exposed sediment in all types of stands. *Lythrum* stands tended to have higher N transformations but the difference was not significant ($P > 0.05$). Across the growing season, surface water NH_4-N and NO_3-N concentrations remained low in both types of stands, indicating strong plant uptake by both species. In the concurrent greenhouse study, *Lythrum* plants transpired about twice the amount of water than *Typha* and depleted N supplied in the standing water (containing 1 ppm NH_4NO_3-N). A consequence of this increased uptake was that *Lythrum* had above-ground and below-ground biomasses that more than doubled those of *Typha*. During the subsequent 3-month decomposition study, *Lythrum* leaf litter lost twice as much biomass than the *Typha* leaf litter. The mass loss of fine root litter was similar between two species. The combined field and greenhouse studies suggest that *Lythrum* invasion could substantially change organic matter distribution, N cycling in both growing and dormant seasons, and water flow and water chemistry in freshwater wetlands, in addition to the visual aboveground species replacement.