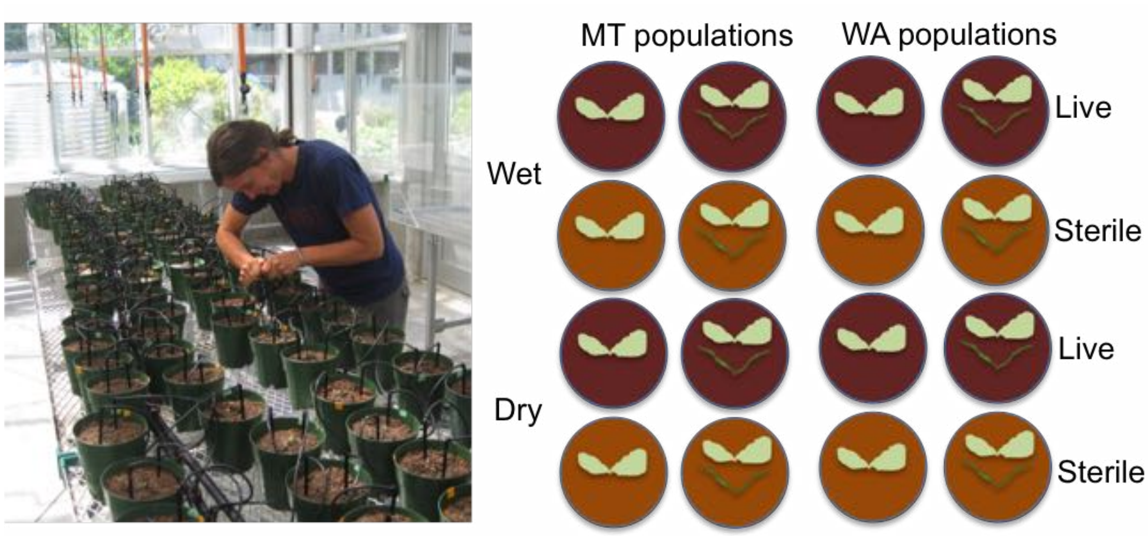
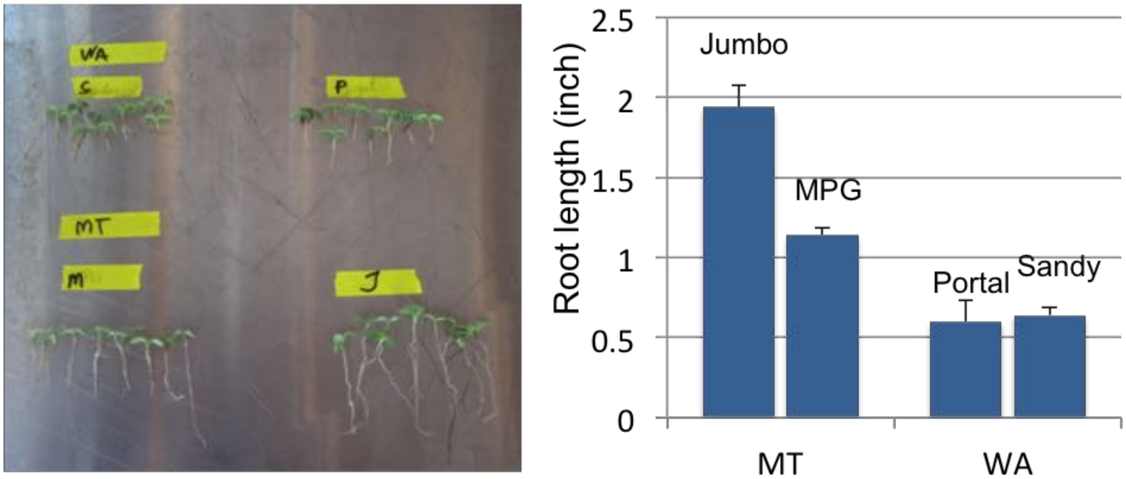
Knapweed occurs along a 37-inch precipitation gradient in the mountainous West, but is only highly invasive in dry regions despite a similar invasion history (Bunn *et al*., 2014, Ecology and Evolution). In an ongoing collaboration between MPG Ranch, Drs. Rebecca Bunn at Western Washington University, and Pedro Antunes at Algoma University in Canada, we explore whether moisture-driven shifts in soil pathogen and mutualist abundances drive shifts in knapweed invasiveness. In early July, we set up an experiment. We grew knapweed alone or with a competitor (*Bromus marginatus* or mountain brome) that co-occurs with knapweed along the entire gradientWe grew the plants in live or sterile soil and under wet or dry conditions (Picture 1).



Picture 1. We designed an irrigation system to maintain low (~12%) and high (~25%) soil moisture (similar to conditions in MT and western WA) during plant growth. In each pot, knapweed (collected in either western WA or MT) was planted with or without a competitor (*Bromus marginatus*) in either live or sterile soil. Dr. Bunn maintains the experiment at the University of Western Washington.

Knapweed has been introduced multiple times to North America, and most populations have a high genetic diversity and show signs of hybridization (Marrs et al., 2008, Molecular Ecology). To avoid bias, we included two populations from each knapweed range (MPG Ranch and Mt. Jumbo from MT; Portal and Sandy from western WA). We made an interesting observation while transplanting 10-day old seedlings; MT seedlings had 2-3 times longer roots ($p<0.001$) than WA seedlings (Picture 2) even though shoots did not differ in size. We did not expect this given the lack of apparent genetic differences among knapweed populations (Marrs et al., 2008), but differences make intuitive sense given the drier conditions in MT versus western WA when knapweed germinates in the field.



Picture 2. Ten days after sowing, MT seedlings had grown 2-3 times longer roots ($p<0.001$) than western WA seedlings but shoot biomass did not differ.

Plants continue to grow fast and Picture 3 shows the experiment after one month. At three months we will end the experiment, harvest the plants, weigh shoots and roots, use a microscope to look for mutualists and pathogens on roots, and use molecular techniques to describe potential differences in microbial communities.

Picture 3. Knapweed and grass growth in the various treatments, one month after transplanting.

ICOM 8 conference

In early August, I traveled to Flagstaff, AZ to attend the eighth International Conference on Mycorrhiza (ICOM). There were more than 500 participants from over 50 countries and I had many opportunities to discuss ideas and network. I was invited to give a talk about relationships between above and belowground diversity. Based on our own data as well as previously published data, I argued that we should not necessarily expect a positive relationship between the two. Instead, I suggested that carbon allocation from plants to the soil microbial community is an underappreciated variable driving belowground microbial richness and diversity. My presentation was well received, and I was invited to contribute my findings for inclusion in an upcoming special issue of Fungal Ecology.

I attended several other thought provoking and well-executed talks. For example, Ian Dickie discussed how deer browsing of exotic mushrooms may help facilitate ectomycorrhizal pine invasion and associated shifts in ecosystem processes. The increased nutrient availability he observed mirrors increases we have documented that seem to be a general phenomenon of invasion.

Mary Firestone discussed soil priming and how arbuscular mycorrhizal (AM) fungi may increase decomposition of soil organic matter by providing carbon to saptrotrophs. These results and methods inspired me to think about decomposition with and without the presence of AM fungi in our experimental plots, which is something we will pursue next year.

Collaborator visit

Following the conference, Dr. Maarja Öpik, a recognized mycorrhizal ecologist from Estonia, visited the ranch (Picture 4). During her visit we spent some time collecting knapweed samples from three locations (MPG Ranch was one) for an ongoing international collaboration between MPG Ranch and Dr. Kadri Koorem at Netherlands Institute of Ecology. This project will look at how knapweed interacts with soil bacteria and fungi, and if these interactions differ in native (southern Europe), expanded (Netherlands), or exotic (North America) ranges. Dr. Öpik and I also discussed phylogeny of soil microbes and the concept of virtual taxa that Dr. Öpik has spearheaded. This concept is based on the fact that we can neither grow nor describe most microbes and therefore we can only identify them based on sequence data. This is problematic when we want to compare results between studies or describe global distribution patterns. Dr. Öpik has made a major contribution toward solving this problem by creating the global online database MaarjAM where researchers can match their sequence types to virtual taxa, which are based on phylogenetic relationships of sequence types. There are about 350 virtual taxa of AM fungi globally but as new sequencing techniques continue to expand our ability to detect taxa, this number will increase.

Picture 4. Dr. Maarja Öpik visited the ranch following the ICOM conference. We spent time sampling knapweed for an international collaboration and discussed ways to analyze our sequence data using the online database of virtual taxa that Dr. Öpik developed.