ORAL PRESENTATION ABSTRACTS

Room 374 Ecological Modeling & Geography

9:00-9:15 Integrating Nasa Earth Observations into Live Fuel Moisture Models to Improve Wildfire Timing and Severity Forecasting in The Eastern Great Basin

Lauren Lad, NASA DEVELOP

The eastern Great Basin (EGB) covers approximately 411,000 km2 within the states of Arizona, Colorado, Idaho, Utah, and Wyoming. Partners at the Bureau of Land Management (BLM), the Idaho Department of Fish and Game, the National Weather Service, and the Great Basin Coordination Center (GBCC) are particularly concerned with Live Fuel Moisture (LFM). Living vegetation that fuels wildfires, referred to as live fuel, requires greater energy input to combust when wet and less energy input to combust when dry, making LFM a vital measurement for predicting wildfire risk and severity. To increase spatial coverage for the EGB from the 155 in situ observation sites, the NASA DEVELOP team modeled LFM using satellite data from Aqua and Terra Moderate Resolution Imaging Spectroradiometer (MODIS) and Suomi National Polar-orbiting Partnership (NPP) Visible Infrared Imaging Radiometer Suite (VIIRS). The team incorporated remotely sensed data into machine learning modeling techniques, such as the Random Trees Classifier through ArcGIS Pro, to develop a predictive model of LFM. Model accuracy was evaluated by testing generated values against historical data obtained from partners at the BLM and the GBCC. The LFM model benefitted partners by improving the spatiotemporal resolution for wildfire forecasts.

9:15-9:30 Utilizing Remote Sensing to Evaluate Herbicide Treatment Efficacy on Invasive Cheatgrass In Medicine Bow National Forest, Wyoming

Chiara Phillips, NASA DEVELOP National Program

Cheatgrass (Bromus tectorum), an invasive plant species in the Western US, occurs in the grasslands throughout Medicine Bow National Forest (MBNF). Cheatgrass is known to rapidly colonize disturbed sites and dramatically alter historic fire regimes and nutrient/water dynamics as well as outcompete native plant species that are important forage for mule deer and elk. In 2012, the Squirrel Creek Fire burned approximately 10,587 acres of land within MBNF, exacerbating the spread of cheatgrass. In 2015, the Wyoming Ecological Forecasting DEVELOP team identified areas of high cheatgrass abundance within the fire boundary to guide US Forest Service (USFS) herbicide spraying efforts to reduce cheatgrass in 2016. To detect conditions in 2019, we incorporated Landsat 8 Operational Land Imager (OLI) and Sentinel-2 MultiSpectral Instrument (MSI) data in machine learning models to create a probabilistic occurrence map of cheatgrass. This map was the basis for an analysis of the effectiveness of aerial spraying methods and to inform USFS future land management decisions. In the output from our final Generalized Linear Model (GLM), we found that treated areas decreased in cheatgrass cover by 36% while untreated areas increased in cheatgrass cover by 6%, suggesting that herbicide treatment has been effective.

9:30-9:45 Wildfire as A Catalyst for Upward Range Expansion of Trembling Aspen (Populus Tremuloides) In the Southern Rocky Mountains

Katie Nigro, Colorado State University

Increased temperatures due to climate warming are expected to result in an upward shift in elevation of species ranges, as they track changes in climate. Significant lags in species migrations have been documented, however, and could be tied to inadequate dispersal or lack of appropriate sites for establishment. Disturbances, like wildfire, may facilitate a more rapid shift in species ranges by reducing canopy buffering and producing more sites where succession can occur in the current climate. We investigated whether the West Fork Fire complex of 2013 promoted range expansion of aspen at its upper limit in the San Juan Mountains, CO by conducting seedlings surveys in burned and unburned areas. Aspen seedling establishment occurred up to 100 meters upslope of previous adult aspen stands and only in burned areas. Most of the aspen seedlings were found in bare or burned soil with low litter depths, suggesting a preference for the reduced organic matter conditions that fires

create. The preliminary findings of this survey indicate that upslope migration of aspen is occurring via seedling establishment after fire in the San Juan Mountains of southern Colorado.

9:45-10:00 Predicting Critically Endangered California Condor Range Expansion to Reduce Development Threats

Arianna Punzalan, Colorado State University

California condors (Gymnogyps californianus) are critically endangered with just over 300 individuals in the wild. Condors narrowly evaded extinction during the 1980s when the population reached a low of 22, causing biologists to bring all remaining wild individuals into zoos for captive breeding programs. By the mid-1990s, condors were being released back into the wild from several release sites in CA, naturally forming two flocks in central and southern CA. Thousands of square miles of currently unoccupied historic condor range separate the two flocks and interactions between the two have been rare. However, movements detected in 2015 and 2016 from central to southern CA throughout the historical condor range and beyond, highlighted a need to understand how condors will use the landscape as their range expands. Unfortunately, alternative energy development, in the form of wind turbines, may proceed within currently unoccupied habitat without considering risks to condors despite the substantial threat it poses to birds. I used condor location data to identify factors that influence home range size and predict range expansion in California. Areas of overlap between predicted condor range expansion and commercially valuable wind generation will inform energy developers of critical habitat to consider during compliance processes.

10:00-10:15 Less but Better: Interaction Between the Amount and Quality of Habitat Drives Mammalian Occupancy in The Brazilian Pantanal

André Regolin, Colorado State University

We evaluated how habitat occupancy by mammals is shaped by an interaction of habitat amount and quality in the Brazilian Pantanal. We predict that when the amount of habitat is limited an increase in habitat quality will improve frugivore occurrence. We also expect that the habitat quality contribution to species habitat occupancy will vary among species according to species sensibility to habitat loss. We combined mammal detection data obtained from camera traps with land use and land cover maps to estimate the amount of habitat and measured habitat quality using local environment variables and distance to waterbodies. We fit univariate, additive, and interactive occupancy models to evaluate the relative support of each model and estimate species-specific occupancy and detection probabilities associated with various habitat features. Our results indicate that high quality habitats can improve occupancy in landscapes with low habitat cover. Our results also demonstrate that habitat quality matters even in landscapes with high habitat cover. Additionally, our findings suggest species sensitivity to habitat amount can determine the importance of habitat quality on occupancy. Although conservation policies tend to focus mainly on habitat amount, landscape management must include strategies to preserve and improve habitat quality.

Room 376 Evolutionary Biology

9:00-9:15 Genetic Diversity Accelerates Population Adaptation to A Shortened Generation Time

Lily Durkee, Colorado State University

The ability of populations to adapt, persist, and thrive in changing environments may depend on the genetic diversity present in a given population. Climate change affects the length and timing of seasons, which can alter or limit the time available for populations to complete their life cycles and successfully reproduce. Here, we assess the ability of populations with different levels of genetic diversity to adapt to a shortened generation time using the red flour beetle, Tribolium castaneum, as a model system. We created higher diversity populations by outcrossing 2-4 of the low-diversity populations together. We then compared the fecundity of the low- vs. higher-diversity populations under a shortened generation time. Preliminary results indicate that higher-diversity populations produced at least double the offspring when compared with low-diversity populations after only a single generation. This indicates that outcrossing alone may be sufficient to accelerate adaptation to a shorter generation time. These results are particularly relevant to populations living at the edge of their ranges, which are more likely to experience shifts in seasonality, possess less genetic variation, and have a higher genetic load when compared with core populations. Our results suggest that rapid adaptation to changes in seasonality can be facilitated by gene flow from other populations, regardless of whether the migrants are adapted to the new environment, through the rapid alleviation of genetic load.

9:15-9:30 Adaptation to Daylength Across Latitude Enables Range Expansion of The Tamarisk Leaf Beetle

Eliza Clark, Colorado State University

For many species moving or expanding their range boundaries, adapting to novel environments is key for further expansion. For hibernating or diapausing species, adapting to environmental cues that indicate seasonal change is crucial. The tamarisk leaf beetle, biological control agent for the invasive weed tamarisk, has rapidly adapted to different daylengths across latitudes that signal to the beetle to prepare for winter. We define a new trait, days until diapause at one daylength, to study adaptation at an individual level. We measured the genetic variation in days until diapause in one population in both home and away environments and the responses of eight populations from varying latitudes to both northern and southern environments. We found that days until diapause was highly variable in its home environment, but not in a novel environment and that the diapause behaviors of beetles from across the range significantly differed in each environment. The variation in days until diapause indicates that adaptive evolution is possible, but only when populations are near their home environment. Despite this, populations have become locally adapted across the range. These results explain an important reason for the success of the beetle and will help predict the rate of its range expansion and control of the target weed.

9:30-9:45 Conservation Genomics of The American Redstart

Matthew DeSaix, Colorado State University

In the past several decades, North American breeding avifauna have declined by approximately 3 billion individuals. In order for these declining species to persist under ongoing environmental change, they must be able to shift their distribution and/or adapt to changing selection pressures. Long-distance migrants in particular are exposed to a wide range of selection pressures throughout their annual cycle. Here, we describe a conservation genomics study of the American Redstart (Setophaga ruticilla): a long-time model species for full annual cycle research of migratory songbirds. Our results reveal finer-resolution geographic genetic clustering than previously reported for American Redstarts. We also detail geographic and environmental variables shaping genetic variation on the breeding ground. We highlight the importance of building on these results and incorporating genomic data into a full annual cycle framework. Specifically, integrating research of migratory connectivity and local adaptation will allow us to tease apart the influence of spatio-temporally variable selection pressures on different avian populations. Ultimately, these conservation genomic models will help us predict how migratory species will respond to climate change and provide an understanding of underlying evolutionary processes.

9:45-10:00 Detetion Of Microgeographic Adaptive Divergence in Spite of Low Genetic Structure in An Island Endemic

Rebecca Cheek, Colorado State University

Theory shows that divergent selection may be undermined at small spatial scales by the homogenizing effects of gene flow. The advancement of genomic techniques has made it possible to discover levels of genetic variation between locally adapted populations that defy traditional assumptions of the spatial scale of adaptation, though few studies have demonstrated this link between genotypic and phenotypic divergence in wild populations. The Island Scrub-jay (Aphelocoma insularis), endemic to Santa Cruz Island, is one of North America's most range restricted species, yet exhibits repeated patterns of differentiation in bill morphology that mimics patterns of adaptive variation between allopatric mainland populations of the same genus. Here, we used single nucleotide polymorphisms (SNPs) to determine if divergent selection has acted on traits that show patterns of adaptive divergence between habitat types and whether environmental variation contributes to genetic structure. We found: 1) genomic variation associated with habitat and candidate loci linked with bill morphology, 2) weak but significant neutral population structure, and 3) evidence of genetic structure related to climate. These results add to the growing body of literature elucidating the capacity for highly mobile wild populations to adapt despite gene flow.

10:00-10:15 Variation and The Origins of a Novel Sexual Signal

James Gallagher, University of Denver

The recent appearance and rapid spread of a new mating song (purring) in Hawaiian populations of the Pacific field cricket has revealed an enormous amount of variation in a historically strongly sexually selected trait. The new song type, discovered in 2017, has sound characteristics drastically different from the ancestral song and is produced by wing morphology intermediate to the ancestral and a previously discovered obligately silent morph. The purring song is attractive to female crickets and less detectable to a deadly acoustically orienting parasitoid fly than the ancestral song, suggesting a private mode of communication among crickets. We recorded and analyzed male songs from long-studied sites and have found extreme variation in song characteristics that is rapidly changing within and among populations. Our findings also suggest that an obligately silent population—used for 15 years as a textbook example of rapid sexual signal loss in response to predation—has become mostly purring within only a few generations. Lastly, we introduce yet another previously unreported distinct song type (rattling) that has become widespread within one of our surveyed populations. Our discovery illuminates the role of variation in the early stages of sexual signal evolution.

Room 378 Human Dimensions

9:00-9:15 Fishing for Answers: Understanding Obstacles to Sustained Local Coral Monitoring in Community Co-Managed Mpas In the Philippines.

Kathrin Hauptfeld, Colorado State University

Data is required to manage and respond to changes in marine systems. Unfortunately, capacity for monitoring is often lacking in regions where biodiversity is greatest. Local monitoring (i.e. citizen science) is increasingly hailed as the sustainable alternative, placing resource decisions more fully into the hands of the affected people, in turn empowering local communities to better manage their resources, particularly in the developing context, where financial and human resources are limited, and local populations are dependent upon dwindling resources.

However, in the Philippines, local coral monitoring has widely failed despite two decades of shared coastal resource management between local governments and fisher-folk. Autonomous monitoring fails to sustain following the withdrawal of the training organizations. In this talk I present results from interviews and focus group discussions with fishers, local government officials, and training organizations to shed light on the question 'Why are local communities failing to adopt and sustain coral monitoring practices?' Results highlight misalignments in resource priorities, perceptions of the value of data, and theories of change among the three groups of actors.

9:15-9:30 "These Days, They Come Daily": Elder Knowledge of Elephant Conflict Around Kibale National Park, Uganda

Martha Bierut, Colorado State University

Human-elephant conflict (HEC) is when human settlements conflict with elephant populations; most often, elephants raid the croplands of community members, decimating local livelihoods. This study uniquely explores the issue of HEC in a montane rainforest system as defined and explained by local community members through semistructured interviews with 28 elders in the village of Kyanyawara, adjacent to Kibale National Park in western Uganda. The most common reasoning for why elephants began to crop raid is that there is food competition within the park (n = 17). Since elephants began crop raiding in Kyanyawara 20 years ago, the elephants have been crop raiding in larger numbers (n = 22), they have been coming in higher frequency (n = 12), and they do not have predictability or seasonality as they have in the past. Mitigation suggestions were to improve and/or extend existing elephant trenches along park borders (n = 19), to improve the response of Uganda Wildlife Authority (UWA) rangers (n = 9), to implement beehive fences (n = 8), and to install electric fences (n = 8). Many opportunities for future research arose from this study, and the authors suggest continuing assessment of community suggestions and needs, close partnership with UWA, and the application of mitigation strategies as suggested by community members.

9:30-9:45 Samburu Pastoralist's Perceptions of Drought Impacts and Adaptations in A Changing Social-Ecological System

Tomas Pickering, Colorado State University

Drought is a concept that varies in meaning and significance depending on the social-ecological activities it disrupts. Climate change is a driver likely to increase the frequency and severity of meteorological droughts in many regions of the world. To better understand how climate change and social-ecological factors interact to produce droughts we need to monitor droughts from community-local perspectives. We conducted focus group discussions with Samburu pastoralist communities in northern Kenya to (1) learn about how they define drought, (2) create a timeline of droughts since the 1970s and gauge their impacts, (3) learn about drought causes, and (4) understand their perceptions of drought-related long-term environmental trends. We then compared community identified droughts to remotely sensed NDVI-anomalies, vegetation droughts. In addition, we found since a 1984 drought, the Samburu have adapted their livestock management, increased their formal education, and diversified livelihoods to successfully resist impacts of climate change and a degrading environment. Women's increased labor roles in society have largely facilitated this adaptation process. This community-based drought information creates a baseline with which to learn about what makes these communities resilient to drought.

9:45-10:00 A Spatial Analysis of Public Ecosystem Service Perceptions in Colorado

James Chamberlain, Colorado State University

Increased frequency of severe wildfire has led to greater pressure being placed on Colorado watersheds to provide a multitude of ecosystem services (ES). However, the spatial perceptions of ES benefits of people living along the Colorado Front Range remains poorly understood. I conducted a public-participatory GIS (PPGIS) mapping survey of households within Colorado's Big Thompson River Watershed (n=125). I assessed perceptions of 12 ES categories through both monetary valuation and mapping in order to understand relative value to beneficiaries of the watershed's services. Spatial patterns were analyzed to identify clustering and hot and cold spots of ES value. I found the strongest ES perceptions to be recreation, water, biodiversity, and aesthetics. Global Moran's I analyses for spatial autocorrelation indicate that overall, ES values are randomly distributed ($I=0.01$; $p=0.23$). However, relational ES values appear to be clustered ($I=0.27$; $p=0.09$). ES value hot spots are located primarily in upstream areas. Cold spots are found in downstream areas. This study builds on PPGIS methods in the region, and continued refinement of these methods will prove useful for watershed management groups. Relating ES value hot spots and fire risk data is the next step in understanding the connections between social ES perceptions and threats.

10:00-10:15 Prescribed Fire Implementation Through A Human Lens: The Role of Landowner Engagement in A Colorado Prescribed Fire Program

Katherine McGrath, Colorado State University

Despite recognition of the value of prescribed fire in scientific literature and policy, a number of factors impede its widespread implementation in the United States. Social acceptance of prescribed fire is a key factor, making consistent and effective outreach important in efforts to increase prescribed fire implementation. The Arapaho-Roosevelt National Forest has set a goal to increase the level of prescribed burning, on its land and at a larger landscape level when possible. As part of this effort, several partners are working to improve active stakeholder involvement and education about forest restoration planning and implementation, with special attention paid to those who may be directly impacted by future prescribed fires.

Our case study on the Canyon Lakes Ranger District of the Arapaho-Roosevelt National Forest analyzes: strategies the USFS and its partners have used to communicate to landowners and meet their goals; challenges and benefits experienced on both the giving and receiving ends of outreach; and how outreach has been perceived by its recipients. Preliminary findings suggest that landowners are most satisfied with accessible, personalized outreach and experiencing successful projects locally, while managers stressed the importance of collaboration in building capacity, trust, and achieving objectives.

Room 374 Landscape Ecology & Global Change

10:45-11:00 How Does Rainfall Event Size Affect Ecosystem Responses During Drought in The Shortgrass Steppe?

Olivia Hajek, Colorado State University

Global climatic models forecast increased periods of extreme dry and wet periods as well as more frequent individual extreme rain events (i.e. deluges). These hydrological shifts are particularly relevant for semi-arid grasslands because of their sensitivity to changes in precipitation. Thus, we designed an experiment at the Central Plains Experimental Region (CPER) to evaluate how deluges affect ecosystem processes, particularly carbon cycling. Using rainout shelters and a watering pump system, we simulated four different precipitation regimes: drought, drought with a single deluge (63mm), drought with several small rain events (total 63mm), and a control receiving average rainfall. We measured changes in soil moisture, soil respiration, net ecosystem exchange, phenology, and number of flowering stalks throughout the growing season, and then at the end of season, we harvested above-ground biomass. Despite noticeable differences immediately following the single deluge, the overall results suggest that neither a single deluge nor several smaller events rescues a droughted system to the productivity of a normal year. These results provide valuable insight into how grassland ecosystem services may change as the result of climate change altering the hydrological cycle.

11:00-11:15 Aridity Drives the Spatiotemporal Patterns of Masting Across the Latitudinal Distribution of a Dryland Conifer

Andreas Wion, Colorado State University

Masting is the synchronous and irregular production of seed crops. Increasing temperatures and shifting precipitation regimes may alter the frequency and magnitude of masting, especially in species that experience chronic resource stress. In this study, we assessed the patterns of masting across the latitudinal distribution of a widely distributed dryland conifer species, piñon pine. Populations from chronically hot and dry areas tended to have greater interannual variability in seed cone production and smaller crop sizes. Mast years generally followed years with low vapor pressure deficits and high precipitation during key periods of the reproductive process, but the strength of these relationships varied across the region. Spatially correlated patterns of vapor pressure deficit better predicted synchrony in seed cone production than geographic distance, and these patterns were conserved at distances up to 500 km. Projected increases in aridity are likely to decrease the frequency and magnitude of masting in these dry forests and woodlands. Declines in seed production may compound climatic limitations to recruitment and impede tree regeneration, with cascading effects for numerous wildlife species.

11:15-11:30 Riparian Insect Diversity Along A Gradient of Pfc Contamination

Mauricio Soriano, University of Colorado, Colorado Springs

Despite risks to human health, polyfluorinated chemicals (PFCs) are used in many industries and consumer products. In Colorado Springs, their use in firefighting foam resulted in Fountain Creek Watershed contamination. PFCs are subject to biomagnification within the food web. Plants being producers uptake PFCs via water-uptake mechanisms passing the toxicant up the trophic ladder. As toxicant concentration increases with trophic level, potential disturbances to the ecosystem increases. Using methods executed at three different scales, we assess PFCs impact on ecosystems mediated through the effects on plants. We have five main goals: 1) Study the impact of PFCs load on biophysical attributes at the landscape scale. 2) Determine how PFCs bioaccumulate and/or biomagnify through the riparian food web. 3)The concentrations of PFC from field-collected plants, insect herbivores, and spiders will be determined using analytical methods. 4) Field collection was coordinated using landscape mapping such that replicate, random samples of the plants and arthropods will occur in impacted and unimpacted riparian areas. 5) Laboratory experiments will determine the extent which the PFCs enter consumers via their diet versus other routes of exposure. Results show that key markers of insect biodiversity declined along the PFC impacted gradient.

11:30-11:45 Regional Scale Assessment of The Mutualism Disruption Hypothesis

Morgan Roche, University of Tennessee, Knoxville

Impacts of invasive species are notoriously difficult to predict because the impacts vary with climatic conditions, composition of the recipient community, and abundance of the invader. Garlic mustard

(Alliaria petiolata) is an herbaceous plant that has invaded many of the forest understories of Eastern North America. This invader impacts recipient plant species by disrupting mycorrhizal mutualisms. Inhibition of mycorrhizae by garlic mustard causes physiological stress in native plants, which results in diminished vital rates and population growth rates, and altered community composition. There is strong support for this mechanistic process in mycorrhizal plant response, but we do not how mutualism disruption changes over space or at across a range of garlic mustard abundance. We assessed the effects of garlic mustard on plant communities across the state of Illinois at a range of garlic mustard abundance. We expected garlic mustard presence to have a stronger negative effect on mycorrhizal herbaceous plant cover in comparison with non-mycorrhizal herbs and that the negative effects would be greater as garlic mustard abundance increases. A stronger impact on mycorrhizal plants would provide support for mutualism disruption as the primary mechanism of garlic mustard's invasive success.

11:45-12:00 The Effect of Group Size On Per Capita Consumption, Longevity and Thermoregulatory Performance in European Honeybees (Apis Mellifera)

Michael Matthews, Colorado State University

Habitat loss, pesticide use, and parasite infections lead to a 30% die-off of North American Honey bee colonies each year. A recent study found that colonies must meet a population size threshold to survive harsh winter conditions. The source of the increased survivability observed in larger colonies remains undetermined. Michener's paradox is a highly studied pattern known to limit group size in social insects. The paradox describes a negative correlation between group size and per capita production (PCP). Despite the intrinsic decline in PCP, Honey bee colonies preparing for winter can grow up to 50,000 individuals strong. In the present study, I investigate the potential advantages of larger group sizes. I hypothesize that larger groups benefit from increased thermoregulatory performance and decreased per capita consumptions (PCC). To test this hypothesis, I maintained large, medium, and small groups of worker honey bees in incubators. I subjected treatment groups to 12 hours of hot (38° C) and cold (18° C) temperatures a day. I recorded PCC and mortality measurements daily. Temperature probes recorded cluster temperature every 10 seconds. Statistical analysis of data collected is ongoing. Initial results indicate that medium-sized groups have the highest survivability, suggesting there is an optimum thermoregulatory density

Room 376 Plasticity & Adaptation

10:45-11:00 Environment, Population and Gene by Environment Influence on Genome-Wide A-To-I RNA Editing

Miles Whedbee, Colorado State University

Adenosie to Inosine (A-to-I) RNA editing is a fundamental post-transcriptional modification in metazoans. An evolutionary role for RNA editing has been hypothesized; however, the specific mechanisms by which editing influences evolutionary trajectories and the degree of impact on evolution is largely unknown. To assess influences of rearing environment, genetics and gene by environment interactions on RNA editing, we used a breeding design that leverages the Trinidadian guppy system for assessing plasticity and repeated evolution of RNA editing. We raised fish from two pairs of high-predation and low-predation populations in common lab environments with or without exposure to chemical cues of predators. We computationally predicted RNA edit sites in brain transcriptomes. Genetic background and rearing experience both partially explain total RNA editing as well as which sites are edited. In addition to global differences in editing, gene-level analyses identified differentially edited sites, i.e. genes in which edit levels differed based on predator exposure, population of origin, or the interaction between population and predator exposure. These results provide both a global and initial gene-level analysis of population genetic variation and rearing environment on RNA editing.

11:00-11:15 Guppy Love: The Effect of Mating Experience on Courtship Behavior in Male Guppies

Nathan Phipps, Colorado State University

Animal mating behavior is influenced by both genetic background and lifetime experience. We sought to investigate how genetic adaptations to environmental stressors interact with events within an organism's lifetime to alter behavior. Reproductively isolated populations of Trinidadian guppies (Poecilia reticulata) occur in environments with either high or low predation rates. Evolutionary history with predators influences many phenotypes, including male courtship strategy. We observed male guppies from high predation, low predation, and intercross populations in their first encounter with a female. After 24 hours, we repeated the mating encounter to observe differences in mating strategy. We recorded occurrences of a variety of courtship behaviors in these encounters to determine how the effect of sexual experience on courtship strategy is influenced by population predation history. Our results describe the extent to which guppies from different genetic lines alter courtship behaviors after experience.

11:15-11:30 Can Plasticity Help Guppies Rise to The Challenge of Sea Level Rise?

Alexander Mauro, Colorado State University

One of the predicted consequences of climate change is an increase in the salinity of estuaries due to sea level rise. To start to understand how fish will respond to this, we investigated how behavior and body condition change in a euryhaline fish, Poecilia reticulata, subjected to a salinity increase and change in competitor composition that mimicked conditions predicted under sea level rise. We found that there is a tradeoff between salinity tolerance and competitive ability that results in a decrease in body condition when P. reticulata is in these conditions. However, our experimental fish were raised in freshwater and it's possible that fish raised in brackish water would respond differently because of the effects of developmental plasticity. Further, it's likely that the individuals that will respond to sea level rise in nature will have developed in brackish water. Hence, we repeated our experiment with fish raised in brackish water. We found these fish did not improve performance in brackish water and decreased performance in freshwater when compared to freshwater developed fish. Overall, we found that in P. reticulata plasticity does not appear to promote persistence in brackish water and that a tradeoff between salinity tolerance and competitive ability could constrain an adaptive response to increasing salinity.

11:30-11:45 Acclimation Capacity as A Buffer to Climate Change: Using A Cold-Adapted Frog System to Uncover Drivers and Assess Estimate Quantification

Amanda Cicchino, Colorado State University

In the face of rapid environmental change, phenotypic plasticity is often an individual's first line of defense. Plastic responses are often fast, and thus can offer a short-term solution for organisms trying to cope with changing environments. Understanding how plasticity in physiological traits affected by temperature (i.e., acclimation) evolves can help us identify trends in coping ability, which can inform conservation action. In this study, we quantified acclimation capacity of a cold-adapted, stream frog

(Ascaphus spp.) along elevation gradients. We also investigated drivers of this plasticity, such as stream temperature variability and the availability of thermal refugia. Further, we used this system as a case study to investigate the approaches used for acclimation capacity. We found that these frogs have low levels of acclimation capacity in their thermal tolerance and high amount of variation among populations, which was not explained by temporal nor spatial variability in temperature. We found that the approach used to estimate acclimation capacity affected inferred vulnerability. Generalizations of physiological plasticity across systems will need to consider a priori expectations of physiological responses to experimental protocol, as well as underlying thermal trends to fully understand population vulnerability.

Room 378 Soil & Nutrient Cycling

10:45-11:00 Using an Isotope Pool Dilution Approach to Quantify Gross N2o Production and Consumption in Soils: Organic C Addition Stimulates N2o Consumption

Emily Stuchiner, Colorado State University

Nitrous oxide (N2O) is a potent greenhouse gas with a warming potential ~300x CO2, but a poorly constrained global budget. N2O consumption, the microbial reduction of N2O to N2, remains one of most uncertain aspects of the global budget because it is difficult to measure. We sought to better understand what drives N2O consumption by measuring this process in eight soils from Colorado, New Mexico, and Minnesota. We hypothesized that the primary control on N2O consumption is electron donor supply. To address this hypothesis, we incubated soils amended with either aqueous organic carbon (OC) or DI water (control) to discern how excess reductants impact gross N2O uptake. All soils were also enriched with 99 atom percent excess 15N2O, held at 60% soil water saturation, and incubated for 48 hr. We then used 15N2O isotope pool dilution to disentangle gross N2O production and consumption in response to the amendments. Our study revealed that N2O consumption was stimulated in response to OC in several, but not all, soils. Soils with a marked increase in gross N2O consumption appeared to overcome a C-limitation threshold, resulting in a depletion of oxidant supply, growth in microbial biomass, and increased transcription of nosZ, the N2O-consuming gene. These results make strides towards better defining the drivers of N2O consumption.

11:00-11:15 Can Intensification and Diversification with Legumes Enhance SOM In Semi-Arid, Dryland Wheat Farms?

Laura van der Pol, Colorado State University

Loss of organic matter (OM) through cultivation and increased drought due to climate change threaten the viability of dryland agriculture which supplies the majority of global grain. One strategy adopted by wheat farmers to enhance SOM has been to replace summer fallow with a pulse crop. This form of intensification has the potential to reduce soil erosion, increase SOM, and enhance farm income. Incorporating a leguminous crop such as peas could offer additional benefit since legumes may promote more persistent (mineral-associated - MA) soil C while enhancing N availability to subsequent crops. We tested whether dryland crop intensification enhanced SOM retention by contrasting wheat-fallow rotations to wheat-corn-millet and wheat-corn-millet-pea rotations in fields that have practiced one of these rotations for at least 8 years (n=5/rotation). We compared the amount of SOM as plant-derived particulate organic matter and microbial/root-derived MA OM and water-stable aggregates from 0-10cm as well as total C and N to a depth of 1m. Preliminary results suggest that intensification did lead to greater soil structure as well as SOM, though the effect of the legume pulse crop is uncertain. Our results will help determine whether legumes could enhance C sequestration on a decadal timescale.

11:15-11:30 Adaptive Multi-Paddock Grazing Increases Soil Carbon Stocks and Soil Health

Samantha Mosier, Colorado State University

Continuous grazing has led to significant losses of carbon (C) in grassland soils. Yet previous research has shown that rotational grazing, specifically adaptive multi-paddock (AMP) grazing, can increase soil C stocks in these grassland systems. By promoting grazing management that improves soil C sequestration and soil health, grasslands have a large potential to help alleviate rising atmospheric CO2 as well as increase the sustainability of the soil. Our research analyzed soils from 10 grasslands in southeast United States representing either AMP or continuous grazing grassland management. We quantified soil C stocks as well as the distribution of C among soil organic matter (SOM) pools with varying mechanisms of formation and stabilization in soils. Additionally, we analyzed several other soil health indicators across each management type. Our findings show that the AMP farms had over 13% more soil C and 9% more soil nitrogen compared to the continuous grazing farms. There were significantly more persistent C on AMP farms compared to continuously grazed farms. Additionally, overall soil health was higher on the AMP grazing sites, indicated by several soil health metrics. These findings provide evidence that AMP grazing could be implemented as a potential way to sequester more C and mitigate rising atmospheric CO2 levels.

11:30-11:45 The Good, The Bad and The Algae: Nitrogen Dynamics in A Large Tropical Lake

Jemma Fadum, Colorado State University

Lake Yojoa is the largest freshwater lake in Honduras and the economic backbone of the surrounding region. In the last 40 years Lake Yojoa has experienced a deteriorating trophic state. We hypothesize that the observed eutrophication is due to increased nutrient loading from land use/land cover changes within the watershed, pelagic loading from aquaculture and climate change related alterations to the physicochemical structure of the water column. Using legacy data from before the introduction of aquaculture and contemporary data on nutrient concentrations and secchi depth, we have reasonable evidence to conclude that Lake Yojoa has increased in trophic state due to altered seasonality of reactive nitrogen delivery. While the dry season, when watershed inputs were minimal, used to serve as a 'recovery period', the delivery of reduced nitrogen to the oxic epilimnion during mixing now maintains an elevated trophic state. These results highlight the importance of understanding the interaction of nutrient loading and seasonal changes in lake stratification. Without a mechanistic understanding of nutrient cycling in tropical lakes, such as Lake Yojoa, it will be difficult to maintain watersheds capable of performing a full range of ecosystem services such as supporting multiple human uses and serving as a natural and economic resource.

11:45-12:00 Predictors of Plant Functional Traits in A Novel Ecosystem

Alexander Goetz, University of Denver

Understanding ecosystem changes due to removal of invasive species requires addressing not only taxonomic species composition but also ecosystem functioning via traits of individual plants. We explore how Tamarix spp. treatment impacts functioning of the surrounding plant community, specifically habitat for the endangered Southwestern willow flycatcher (Empidonax traillii extimus). Its habitat is associated with tree branching structures (a functional trait) and presence of water (an abiotic characteristic), not species composition; it is unknown whether restoration activities are producing such conditions. We ask: Which removal methods and site characteristics in formerly Tamarix dominated stands predict ecosystem function optimal for endangered bird habitat? I sampled specific leaf area (SLA) and branching structure at 34 sites in Grand County, UT. Soil samples were also collected at these sites. I found high variability in both SLA and branching structure between sites and reaches, with a significant effect of soil electrical conductivity on vertical biomass distribution. Ecological function of novel ecosystems is particularly important in the context of evaluating land management outcomes; we seek to improve our understanding of the functional trajectory of degraded environments after restoration activity has occurred.

POSTER PRESENTATIONS

Aquatic Ecosystems

1 Advancing the Science and Practice of Conserving Hihiwai (Neritina Granosa): Using Ecology and Traditional Ecological Knowledge to Identify and Overcome Threats to An Endemic Hawaiian Gastropod

Kiloaulani Ka'awa-Gonzales, Colorado State University

Aquatic gastropods make important contributions to global biodiversity and provide vital ecological services. Hihiwai, an anadromous gastropod, is dependent on healthy freshwater streams and has cultural and subsistence value to local communities. The objectives of this study are 1) estimate hihiwai population densities within and among four streams in Hawaii along a longitudinal gradient and across age classes, 2) identify the ecological and anthropogenic factors associated with hihiwai density, and 3) identify how traditional ecological knowledge of local communities can be integrated into understanding the ecology of this species and ensuring long-term community engagement in conservation efforts. We will sample hihiwai using a visual point quadrat technique and measure adult shell length. We will also record a suite of geomorphological, hydrologic, and climatic characteristics perceived to impact hihiwai density. In addition to reporting our ecological findings, we will conduct mixed methods qualitative inquiry in the local Molokai community through interviews and participatory mapping. We expect the results of this study to provide new insights into the value of aquatic “bioindicators” such as hihiwai, in developing effective local stream management strategies that benefit both ecological and human communities.

2 Defining the Anthropocene In the Alpine: How Has Recent Global Change Altered the Ecology of Alpine Lakes in The Sierra Nevada Mountains, California?

Caitlin Charlton, Colorado State University

High-elevation mountain lakes are some of the most sensitive systems to anthropogenic change, experiencing increased air and water temperatures, decreased snowpack duration, delayed lake ice-on and earlier lake ice-off, lake acidification, and increased loading of nitrogen and phosphorous from atmospheric deposition, snowpack melt and internal cycling. A major proxy for these changes is lake primary productivity, where algal communities exploit excess nutrients and conditions conducive to increased growth. Lakes in California’s Sierra Nevada have been observed to be greening over the past several years. Using pigments preserved in lake sediments from the Sierra Nevada, we will be evaluating the timing of changes in historical mountain lake productivity and the drivers of these changes from the end of the 19th century to the present. We expect to find shifts in algal community abundances to correlate with the timing of global change drivers, with specific increases in the total abundance of algae and the abundance of green algae. We predict that nutrient loading such as nitrogen deposition and phosphorous loading, variability of interannual snowpack and warming temperatures will be particularly important drivers of observed increased Sierra Nevada lake productivity.

Disturbance and Restoration Ecology

3 Feasibility of Avicennia Marina (Grey Mangroves) In Salt Removal from Water

Brandon Dusenberry, Angelo State University

Phytoremediation is becoming a more popular way to remove certain contaminants in a given soil. From removing chromium with mangrove trees or in extreme cases phytoremediation can be used to remove carcinogenic benzene from the groundwater table from a chemical spill. In this study Avicennia Marina “Grey Mangrove” was used to see if this plant removes salt in the water that it was planted in. With this design we hope to integrate it into a real-life situation in which it could be beneficial to the public.

4 Do Macroinvertebrates Indicate Restoration Success in Semiarid Freshwater Pools? Evidence from The Mora River Watershed, New Mexico

Richard Patsilevas, Regis University

Land cover change and climate warming exacerbate arroyo formation in the American southwest by accelerating water movement through the river network. Increased ephemerality in degraded arroyos results in depauperate macroinvertebrate communities consisting primarily of desiccation-resistant taxa. The Rio Mora National Wildlife Refuge (RMNWR) aims to improve freshwater biodiversity by installing one-rock dams that enhance water retention. We assessed whether one-rock dams improve freshwater biodiversity by collecting macroinvertebrate samples from 3 permanent pools in 5 canyons along a restoration chronosequence within RMNWR. We also rehydrated sediment collected from ephemeral pools along hydroperiod gradients in each canyon to measure invertebrate biodiversity in the seedbank. In permanent pools, we found very few (~3%) mayflies, stoneflies, and caddisflies, indicating a general lack of sensitive macroinvertebrate taxa. Although aquatic macroinvertebrates emerged from the seedbank after 8 weeks in 20% of samples rehydrated from ephemeral pools, we found only nominally increasing relationships between invertebrate diversity and time since restoration. These results indicate that other invertebrate metrics robust to environmental variation across these restored arroyos should be explored to assess the efficacy of one-rock dams.

5 Post-Fire Forest Recovery and Transition

Jesse Wooten, Colorado State University

A changing climate combined with historical forest management practices have altered disturbance regimes across the western U.S., resulting in increased wildfire frequency and severity. The window of conditions favorable for conifer regeneration has narrowed due to increases in temperature and decreases in moisture. These effects are further compounded in severely burned areas where canopy cover has been reduced, thereby exposing the ground to increased sunlight. We examined montane forest sites that burned at low and high severity in the Spring Creek Fire (2018) in the southern Colorado Rockies. One-year post-fire, we observed vegetative recovery dominated by aspen and gamble oak resprouts with an absence of conifer regeneration and little plant cover otherwise. This pattern held true across elevations and forest types, including forested areas previously dominated by ponderosa pine and Douglas-fir or pinyon-juniper. This study has implications for forest managers and landowners implementing post-fire management and restoration.

6 Effects of Bison Grazing Intensity on Plant Community at Rio Mora National Wildlife Refuge

Alexandra Sorenson, Regis University

Bison (Bison bison) grazing can restore degraded grassland ecosystems by increasing the plant species diversity across the landscape, but these effects differ depending on the type of grassland and duration of the grazing. Refuge managers at the Rio Mora National Wildlife Refuge (RMNWR) have used bison to restore shortgrass prairie ecosystem function across the site. We hypothesized that higher bison grazing intensity increases plant species richness and diversity because of the bison's tendency toward mosaic grazing and increased nutrient deposition. We surveyed 30 randomly-placed 100-m^2 plots in four different areas of the refuge across a range of bison-grazing intensities. Within each plot, we recorded scat, plant species richness, and percent cover by species for a 1-m^2 quadrat. Areas with the highest grazing intensity showed lower plant species richness and areas with the lowest grazing intensity showed higher plant species richness. Our results suggest that higher bison grazing intensity might decrease the plant species richness and diversity across the landscape, which does not support our hypothesis. However, we observed higher grazing from non-bison grazers in the low bison grazing areas, so it is reasonable that the presence of other grazers could impact the plant species richness and diversity in these areas.

Molecular Population Genetics

7 Causes of Differences in Migratory Timing in Neotropical Migrants

Taylor Bobowski, Colorado State University

Migration, animals' seasonal movement, lets organisms exploit favorable conditions across a large geographic area. Despite this common purpose, populations of the same species can exhibit dramatically different patterns of movement. Ruegg et al 2014 showed that in Wilson's Warblers, distinct populations differed significantly in migration timing, but the causes remain unknown. Modern genomic methods allow for the identification of specific genes underlying migration as well as how they may be influenced by environmental selection. Moreover, modern genetic methods can be used to identify migrant populations at finer spatial scales and assess the potential for population-specific migration timing across species.

The goal of this study is to determine the drivers of differences in migratory timing between populations. Our hypothesis is that populations migrate at different times due to selection on genes relating to migratory timing, which differs between distinct breeding populations. We chose Common Yellowthroats as a study species due to their extensive breeding range and large collection of samples. We assessed key sites along the migratory corridor for population specific migratory timing. A survey of variation in genes linked to migratory behavior in other species was taken to assess the role of selection in migratory timing.

8 Evaluating the Effects of Climate Change on Yellow Warblers Using Telomeres as A Biomarker of Fitness

Marina Rodriguez, Colorado State University

The ability of populations to persist when faced with changing conditions depends on their capacity to adapt. Genomic vulnerability tells us how much allele frequencies need to change for populations to keep up with predicted changes in climate by 2050. In Yellow Warblers, the most vulnerable populations reside along the Rocky Mountains. These vulnerable populations are also currently undergoing population declines, suggesting that they may already be experiencing negative impacts from climate change. The relationship between genomic vulnerability and population trends is not conclusive, however, and a direct link between genomic vulnerability and fitness is needed to confirm that vulnerable populations are currently undergoing declines due to climate change. A biomarker that captures individual fitness is telomere shortening. Telomeres protect the chromosomes and shorten with age and stress. The correlation between telomere loss and survival in many species has led to telomere shortening rate being used as a fitness proxy in many studies. My proposed work will use telomere shortening to indicate fitness loss resulting from climate across Yellow Warbler range. The goal of my proposed work will be to develop biomarkers to test the hypothesis that high genomic vulnerability is correlated with current fitness.

Wildlife Ecology

9 Neotropical Reforestation & Avian Habitat Selection Dynamics in The Monteverde Reserve Complex, Costa Rica

Shane Way, Metropolitan State University of Denver

Habitat loss and degradation present leading mechanisms associated with global avian population decline. From a biodiversity lens, it is essential to investigate bird communities and their associated habitat-selection dynamics based on used-habitat vs available habitat in order to develop effective conservation plans. In our habitat-selection study, ten reforested sites of varying age were sampled in the Monteverde Reserve Complex, Costa Rica. Data were collected between February and May 2018. New forest-habitat structure varied since being reforested (2003, 2008, and 2011) and was compared to a climax forest. Avian species compositions varied with each successional class. Most migrants were detected in the youngest successional class. Our preliminary data suggests that migratory species may be frequently outcompeted for ideal habitat sites & forced into occupying lower quality, homogeneous, early succession forest habitat. This trend appears to be nonlinear, and only holds for the youngest successional habitats. Afterwards, there was no discernible difference when compared to uncut forest. The youngest reforestation class had greater total species abundance, richness and was the least heterogeneous. This suggests that early succession, homogeneous forest provides habitat for birds & may especially provide critical habitat to migratory birds.

10 The Use of Mitochondrial DNA To Indicate Movement and Interactions of Little Brown Bats to Evaluate the Spread of White Nose Syndrome

Robyn Hall, Fort Lewis College

White-Nose Syndrome (WNS) is a newly emerging disease caused by the fungus Pseudogymnoascus destructans. Although WNS has spread across the northeastern and midwestern US, it has not been detected in Colorado. Little brown bats (Myotis lucifugus) have experienced high mortality rates (>90%) in areas affected by WNS and is believed to be transmitted primarily through direct contact between bats. Understanding the movement and interactions of separate bat populations can provide insight into how Pd is dispersed across the landscape. The genetic structure of M. lucifugus populations in Colorado is not well understood. This limits our ability to predict how Pd will spread if introduced in Colorado. We used mtDNA markers to determine the population structure of separate populations and determined how genetic differences correspond to physiographic regions and topographic migration barriers. Based on multiple analyses, Colorado bats are most closely related to bats in the Northeastern US, indicating that there is some degree of population interconnectedness between bats from these distinct geographic regions. These genetic patterns may result from historical distribution of M. lucifugus or current mixing of populations. The Rocky Mountains appear to be the predominant geographic barrier to population mixing in this species.

11 Bat Roosts Along Cliffs: Using Rock Climbing Surveys to Understand the Roosting Habitat of Bats Along the Front Range of Colorado

Michael Matthews, Colorado State University

Bats have been declining at an alarming rate because of white-nose syndrome and wind energy development. Massive mortality events from white-nose syndrome have been easy to identify at caves in mines in eastern North America. However, winter roosts with millions or thousands of bats are scarce in western North America; thus, documenting and responding to precipitous declines will be problematic for western land managers and biologists. An effort to identify where bats are roosting is the first step to conducting monitoring to assess such changes. One such effort is to identify bat roosts in cliff walls. Although many biologists understand bats use cliff systems, there have been few opportunities to identify such roosts without expensive telemetry research. An alternative is to collaborate with recreational rock climbers who know where bats roost, or to employ climbers to conduct surveys for bats. We conducted climber-based surveys in Jefferson County Open Space (JCOS) and City of Boulder Open Space and Mountain Parks (OSMP) to find roosting bats. Over approximately two months of surveying 50 climbing routes, climbers identified two roosts on OSMP lands and received a citizen-science record from JCOS lands.

12 Assessing Bison Activity at Rio Mora National Wildlife Refuge to Predict Potential Impacts on The Shortgrass Prairie

Bradley Hamilton, Regis University

Bison are keystone modifier species that help shape grassland ecosystems through behaviors such as grazing and wallowing. Within bison herds, large males dominate during the mating season. At the Rio Mora National Wildlife Refuge (RMNWR) in New Mexico, collecting baseline data on the bison herd will help managers evaluate the bison's impact on short-grass prairie. We hypothesized that: (1) bison will be constrained by their energy budget and will spend more time grazing and resting (passive behaviors) than locomoting and mating (active behaviors); (2) mating success is related to body size; larger males will exhibit more mating behaviors compared to smaller males. We conducted 30-minute focal samples on male and female bison, marking their behavior every minute (17.5 total hours) and 30-minute all-occurrences sampling on mating and aggression behaviors (7.5 total hours). As predicted, the bison spent 46.27% more time exhibiting passive behaviors than active behaviors (p-value<0.001; 95% CI: 29.23-63.32%). Large males exhibited, on average, 1.87 more mating behaviors per sampling period than small males, but this difference was not significant (p-value=0.078). Overall, these findings will help RMNWR managers better use the bison and their energy budget for managing the shortgrass prairie and understand herd dominance dynamics.

Insect Ecology

13 The Impact of Variation in Metabolic Rate on Individual Foraging Behavior in European Honeybees

Julian Cassano, Colorado State University

The European Honeybee, Apis mellifera, is a eusocial insect in which specialized bees, or foragers, carry out the sole responsibility of gathering food for the rest of the colony. Previous research has successfully used optimality models, based in economic theory, to look at a bee's energetics during a foraging flight and predict behavioral outcomes. Although it is understood that foraging behavior can be explained in terms of energetics, the relationship between a foragers metabolic rate and foraging behavior is not clear. Honeybees are known to exhibit consistent individual differences in metabolic rate, and metabolic theory suggests that metabolism can drive behavioral and life history traits. How metabolic rate affects foraging behavior in honeybees is still poorly understood. I will quantify the foraging behaviors of bees that have been artificially selected to exhibit varying metabolic phenotypes. If foraging behavior covaries with different metabolic phenotypes, metabolic rate must be an important constraint foraging behavior and therefore should have consequences on overall colony growth and survival.

14 Drivers of Year-To-Year Variation Insect Abundance and Diversity Along an Elevation Gradient

Kyle Kosinski, University of Colorado at Colorado Springs

Insect populations are in the midst of global decline. One key factor that may affect abundance in Colorado is snowpack. We sampled insects and ants from 20 different sites ranging in elevation in 2017, 2018 and 2019, years with varying snowpack. Specimens were classified by Order and species using a microscope and dichotomous keys. We performed statistical analysis using R package 'vegan' on richness, evenness and abundance. We found light, elevation and soil moisture to be critical factors affecting insects and ants, but these patterns between the three years had strong effects on family and species richness, abundance and diversity.

15 The Roles of Adaptation and Phenotypic Plasticity in Morphology and Performance of An Invasive Species in A Novel Environment

Marcel Kate Jardeleza, Colorado State University

Phenotypic plasticity, when a genotype can produce multiple phenotypes in response to the environment, may be a key survival strategy for invasive species. Invading organisms must cope with novel temperatures and growing research has suggested shifts in ectotherm species distribution due to climate change. Thus, understanding the adaptability of a plastic trait of an invasive species is important in understanding biological invasions in the face of climate change. My subject is an invasive species, Drosophila suzukii, which preliminary studies suggest increases in wing size with elevation. I hypothesize that the variation is due to plastic responses to the environment, genetic differentiation from environmental adaptations, or a combination of plasticity and population-level genetic differentiation where plasticity is either adaptive or non-adaptive. I collected flies from high and low elevations and used their descendants in a reciprocal environment experiment where the flies were reared in high and low elevational temperatures. I then analyzed wing size and number of offspring produced as a function of the source of the flies to determine which hypotheses is supported. Understanding the strategies that allow for species to establish in novel systems is important in creating methods of control and maintaining ecosystems.

16 Differential Effects of Phosphorus Fertilization on Plant Uptake and Rhizosphere Microbiome of Cultivated and Non-Cultivated Potatoes

Hugo A. Pantigoso Guevara, Colorado State University

There is evidence that shows that phosphorus (P) fertilization has a moderate effect on the rhizosphere microbial composition of cultivated crops. But how this effect is manifested on wild species of the same crop is not clear. This study compares the impact of phosphorus fertilization on rhizosphere bacterial community composition and its predicted functions, related to P-cycling genes, in both cultivated and non-cultivated potato (Solanum sp.) plants. It was found that the biomass of non-cultivated potatoes was more responsive to P fertilization as compared to cultivated plants. Differences in general bacterial community composition patterns under increasing P amendments were subtle for both potato groups. However, potato genotype significantly influenced community composition with several bacterial families being more abundant in the cultivated plants. In addition, the predicted phosphatases had lower abundances in modern cultivars compared to non-cultivated potatoes. In summary, despite higher accumulation of P solubilizing bacteria in the rhizosphere of cultivated plants the responsiveness of these plants to increase P levels was lower than in non-cultivated plants.

17 Nitrate (No3-), Carbon Concentrations Are Important Predictors of Carbon Utilization Across A Broad Range of Soils

Torrey Stephenson, Colorado State University

Carbon dioxide (CO2) emissions are a large driver of global climate change. Soil microbes contribute a substantial fraction of atmospheric CO2 through emissions from respiration, but it is not well understood what drives microbial uptake of soil organic C, which causes respiration. To determine if edaphic factors such as soil pH, C:N ratio, soil organic carbon, or inorganic nitrogen (NO3-, NH4+) are significant predictors of differing C uptake, we compared CO2 emissions from seven soils in Colorado, New Mexico, and Minnesota that were either amended with aqueous organic carbon or DI water (control). These edaphic properties were measured for each soil, then soils from each site were divided and amended. CO2 emissions were measured after a 48-hour incubation period using a benchtop infrared gas analyzer. We found that CO2 emissions increased between 30% and 272% from the organic carbon amended soils compared to control soils. These differences in emissions measured between the two treatments indicate C utilization. NO3-:CO2 ratio, NO3- concentration, and % inorganic nitrogen as NO3- were all found to be positively correlated with C utilization. Further research of soil properties that influence C utilization can help inform land management strategies to mitigate the release of this gas to the atmosphere.

18 Recovery of Carbon and Nitrogen Cycling Post Drought in A Grassland System

Leena Vilonen, Colorado State University

Climate models predict an intensification of the hydrological cycle, with more arid regions forecast to become drier and experience more intense and widespread drought. Thus, there is a pressing scientific, economic and societal imperative to understand the impacts of intensifying drought on agricultural ecosystems, particularly those deemed most vulnerable to these events. This study sought to understand whether post-drought ecosystem carbon and nitrogen cycling is able to recover without intervention or if conservation efforts are needed. This experiment had three treatments: (1) ambient rainfall, (2) chronic drought (66% reduction in rainfall), and (3) intense drought (100% reduction for 60 days). To understand recovery of the carbon and nitrogen cycle in this experiment, we measured soil respiration, microbial respiration, total organic carbon/nitrogen, carbon and nitrogen mineralization and potential enzymatic activities of carbon and nitrogen cleaving enzymes monthly over the growing season. Our results indicated that both drought treatments are experiencing decreases in carbon cycling activity (soil respiration, enzymatic activity) at the beginning of the season but experienced quick recovery in ambient rainfall conditions.

19 Soil Aggregates - The Tiny Homes of Soil Organic Matter

Rebecca Even, Colorado State University

Soil is the largest terrestrial carbon (C) pool, storing C as soil organic matter (SOM). However, unsustainable agricultural practices have reduced SOM by 30-50%. To ensure food security and help mitigate climate change, we need to adopt management practices that regenerate SOM. One way is to increase soil structure by preserving aggregation. Aggregation is thought to promote SOM formation and protect it from further mineralization. Recently, our lab introduced a new paradigm proposing two different pathways of SOM. One pathway contributes distinctly to the formation of particulate organic matter (POM) from the decomposition of structural plant inputs while the second adds to the mineral associated organic matter (MAOM) from water soluble plant components and their microbial transformations. I aim to explore how aggregation affects both pathways to SOM formation and its protection as it has never been studied before. I will track SOM dynamics using isotopically enriched soluble and structural plant components in a yearlong incubation experiment. Results from this research will provide mechanistic understanding useful to improve larger scale SOM modeling and highlight how important soil structure is for soil productivity and climate change mitigation. All contributions will help inform decisions for sustainable soil management.

20 Not All Soil Carbon Is Made Equal: Understanding Differential Effects of Global Environmental Change on Soil Organic Matter Components

Katherine Rocci, Colorado State University

Understanding human influence on carbon (C) cycling is crucial for assessing stability of our ecosystems. Increasing or maintaining C storage is often cited as a way to prevent carbon dioxide (CO_2) build-up in the atmosphere, which contributes to climate change. Further, soil C represents the largest terrestrial C pool so understanding soil C is especially important for predicting future C dynamics. However, even after decades of researching soil C responses to global change, we have yet to reach consensus on responses to phenomena such as increasing temperatures and N pollution. To understand the stability of soil C in light of these global changes, we propose separating soil C into two distinct components: one that is associated with soil minerals and is thus more stable (mineral-associated organic matter; MAOM), and one that is not associated with minerals, and is thus less stable (particulate organic matter; POM). We will first survey the literature on responses of MAOM and POM to various global change factors to obtain baseline knowledge on this subject. This survey will then inform experiments determining which ecosystem properties are associated with changes in MAOM and POM. Greater understanding of these responses will allow us to more accurately forecast C cycling and inform land management for greater soil C storage.

Ecological Tools

21 Long-Term Seasonal Dynamics in Reservoir Surface Area Amid Rapid Urbanization. A Case Study of Fossil Creek Reservoir, Fort Collins, Colorado

Melak Senay, Fossil Ridge High School

The Fossil Creek Reservoir (FCR), constructed in 1902, is surrounded by the FCR Natural Area which was established by the City of Fort Collins in 1998 to protect wildlife and prevent urbanization. The FCR is designed to meet several objectives by storing and releasing water for agriculture, municipality, and habitats. We quantified seasonal surface area dynamics for FCR using Landsat 5 (1985-2011) satellite data. The Normalized Difference Water Index (NDWI) was applied in Google Earth Engine to quantify water surface area changes. A total of 725 images were processed to produce monthly NDWI values. The Water Surface Area of the FCR was determined by counting the pixels that were greater than the 0.3 NDWI threshold. Zonal summary statistics of the reservoir area were summarized in Microsoft Excel. The seasonality of the reservoir area was calculated as the mean surface area value for each month over 27 years. The seasonality exhibited a maximum water area of 3.7*106 m2 (906 acres) occurring in January and a minimum in September with 1.5*106 m2 (382 acres). The September surface area was 58% lower than the maximum, suggesting a strong use of stored water for irrigation over the summer. Such analysis is useful to understand the behavior of an important water body like FCR and monitor if it meets its intended use over the years.

22 Applications of High-Frequency Monitoring Networks for Water Quality

Natalie Schmer, Colorado State University

Direct monitoring and rapid communication of water quality is important to ensure ecosystem and public health. Water quality directly controls aquatic organism health and impacts water use for drinking, municipalities, and recreation. Following a large fish kill in the Cache La Poudre River in summer 2018, the City of Fort Collins partnered with Colorado State University and In-Situ, inc. to implement a high-frequency water quality monitoring network using in-situ sensors. A network such as this allows for continuous and real-time monitoring of water quality through space and time, allowing for rapid response to changing hydrologic conditions. The sensor data can be used to understand how the river is changing, as well as an early warning system of water quality change to prevent and respond to future problems like fish kills. For example, we can see sharp changes in river metabolism as the river flows through the city, highlighting how human induced land use change (eg. agriculture and urbanization) impact the ecosystem and water quality. Possible future research using this data include how dissolved oxygen is impacted from flow alteration and differing magnitudes of flow events, how salinity is influenced based on watershed land use, and how flowpaths affect the timing and transport of pollutants with regards to runoff.

23 A Shared Imaging and Analysis Center to Accelerate Root Ecological Research At CSU

Kevin Lehner, Colorado State University

Generating high quality measurements of plant features is a limiting factor in plant ecological research. This has led to sensor and image-based phenotyping becoming hot topics in plant biology. There are many labs at CSU that are working to understand the ecology of roots as well as the genetics underlying root architecture, yet traits associated with plant root systems remain particularly challenging to measure. This is due to both the largely underground nature of roots and the complexity of these structures. In 2018, GDPE contributed funds to develop a washing station in the Plant Growth Facilities (PGF) to clean and process excavated roots. Last year, we purchased equipment to open a new Plant Imaging Center in the PGF, funded by GDPE. This facility will simplify the analysis of roots and other plant structures, using traditional tools and new image-based phenotyping approaches.

The Plant Imaging Center is in the north section of the PGF, in Room 111. We will be hosting a spring open house in late February. The facility currently houses a large format scanner with root analysis software, a camera-based system for taking images of root systems from multiple angles, scales, and a stereo microscope equipped with a camera. Please contact Kevin Lehner (kevin.lehner@colostate.edu) for more information and access.