Previous award recipients from the David Redden Conservation Science Fund Small Grants Program for Conservation Research at Black Rock Forest

2024

Eichert, Anna | *American Museum of Natural History* | "Uncovering the diversity of aquatic macroinvertebrates in Black Rock Forest"
Abstract: PhD student, Anna Eichert, and her advisor Dr. Jessica Ware will produce a working taxon list of aquatic insect species that exist in the reservoirs and ponds located within BRF. Like many insects, aquatic macroinvertebrate populations have experienced a substantial global loss of biodiversity due to climate change and negative human interaction. As indicators of water quality and ecosystem health, aquatic insects exist as safeguards over freshwater ecosystem balance and function. The species list created through this project will serve as an educational tool and baseline for ecological monitoring of aquatic insect community dynamics over time to best maintain biodiversity and watershed resources.

Frank, Craig | *Fordham University - Louis Calder Center* | "The relationship between pond habitats, foraging, and the resistance to white-nose syndrome (WNS) in little brown bats"
Abstract: White-nose Syndrome (WNS) is a mycosis that severely affects little brown (*Myotis lucifugus*) bats. It is caused by an extensive skin infection with the fungus *Pseudogymnoascus destructans* (Pd) during hibernation. Populations of *M. lucifugus* in NY state have recently evolved an increased resistance to Pd infections. The levels of linoleic acid and several other anti-Pd fatty acids present in the wing epidermis of *M. lucifugus* collected in NY has increased by 100% since 2008, and this appears to be one of the mechanisms by which the resistance to Pd has increased. The goal of this study is to determine the role of prey insect fatty acid composition in the foraging activity and dietary preferences of this recovering *M. lucifugus* population.

Pereira, Kathleen Aria Carreras | *Columbia University* | "Critical tests of hypotheses on positive biogeochemical feedbacks of mycorrhizal symbioses"
Abstract: My project aims to test two hypotheses related to the positive feedbacks associated with mycorrhizal symbioses, using observational studies in Black Rock Forest where different mycorrhizal-dominated stands coexist: 1) the core biogeochemical hypotheses of the Mycorrhizal-Associated-Nutrient Economy framework which poses that Arbuscular mycorrhizal (AM) dominated forests are characterized by a more labile, inorganic-N-dominated nutrient economy, whereas Ectomycorrhizal (EM) dominated forests are characterized by a more recalcitrant, organic-N-dominated nutrient economy and 2) the bimodality in tree growth rates to determine whether AM-associated trees grow better when surrounded by AM-associated trees, and vice versa for EM-associated trees.

Radigan, Seosamh | *City University of New York - City College* | Leaf phenology driver in Acer saccharum: comparison of genetic and abiotic factors in sugar maple leaf phenology
Abstract: Deciduous leaf phenology plays a crucial role in plant fitness and ecosystem function, yet its precise timing within populations remains a complex ecological puzzle. This study investigates the drivers of leaf phenology variation in *Acer saccharum* (sugar maple) at Black Rock Forest, New York. We will combine previously collected phenological data with newly acquired genetic information to test whether genetic variation significantly influences leaf emergence and fall, or if environmental factors do. Using RADseq technology, we will sequence thousands of genetic markers in individual trees, allowing us to calculate pairwise genetic distances across the population. These genetic distances will then be compared to corresponding pairwise phenotypic distances, derived from the observed timing of leaf emergence and fall. Employing linear mixed effects models, we will assess the correlation between genetic and phenotypic

distances, while accounting for potential influences of environmental (elevation), demographic (diameter), and geographic (Euclidean distance) factors. Our findings will shed light on the relative importance of genetic and environmental factors in shaping leaf phenology variation within this population. If a strong correlation emerges, it suggests that genes play a key role in dictating leaf timing, potentially facilitating adaptation to changing climate conditions. Conversely, a weak or absent correlation would indicate that environmental factors, such as microclimatic variations, are correlated. This study holds significant implications for the future of sugar maple populations. If genetic factors dominate, identifying individuals with favorable adaptations could guide conservation and restoration efforts, ensuring the survival of this iconic species in a changing climate. Conversely, if environmental factors reign supreme, management strategies must focus on understanding and managing microclimatic variations to foster synchronized phenology and mitigate potential ecological disruptions. Ultimately, this research endeavors to unravel the intricate interplay between genetics and environment that governs the captivating leaf phenology of *Acer saccharum*. By deciphering the hidden score within its genome and analyzing the surrounding ecological stage, we hope to contribute to a deeper understanding of ecological resilience and inform future conservation strategies for this species in the face of a changing climate.

Reed-Sanchez, Edwin | *City University of New York - Bronx Community College* | Black Rock Forest camera AI

Abstract: Black Rock Forest's vast trail network is instrumented with an integrated WiFi mesh providing backbone connectivity ideal for environmental sensor grids. I propose developing intelligent camera traps that leverage this existing wireless infrastructure to enable AI-assisted monitoring of biodiversity dynamics. The system will use machine learning models to automate species classification from video clips. Initial instrumentation will concentrate on augmenting ongoing manual deer censusing traversing snow-covered ground after storms. Estimated year-round populations and behaviors could be validated against intensive human tracking efforts. With refinement, the technology promises expanded infrastructural support for longitudinal surveys of mammals, birds, herpetofauna, and insects at scales infeasible solely in situ. Camera trap studies have effectively quantified multi-species occupancies and abundances unattainable via direct observation alone. This project seeds collaborative deployment of an enhanced, enduring perceptive capability amplifying ecological teams' insights using contemporary computing. Integrating solar power and edge intelligence promises a new understanding of Forest inhabitants to guide science-based conservation.

2023

Frank, Craig | *Fordham University - Louis Calder Center* | "Dietary Linoleic Acid and the Resistance to White-nose Syndrome (WNS) in bats"

Abstract: White-nose Syndrome (WNS) is a mycosis that severely affects little brown (*Myotis lucifugus*), Indiana (*M. sodalis*), northern long-eared (*M. septentrionalis*) and tricolored (*Perimyotis subflavus*) bats. It is caused by an extensive cutaneous (epidermis & dermis) infection with the fungus *Pseudogymnoascus destructans* (Pd) during hibernation. Infected bats arouse more frequently from torpor during hibernation, which leads to a premature depletion of body fat reserves, and death. *Pseudogymnoascus destructans* (Pd) was first observed at a single cave in New York State during the winter of 2006-2007, and it then spread to 5 more caves/mines in New York State during the winter of 2007-08. It has since spread to 39 U.S. States and 7 Canadian provinces, and Pd was introduced to North America from Europe. Three field studies subsequently conducted at NY hibernation site just 53 km North of Black Rock Forest (Williams Preserve Mine) have revealed that the population of *M. lucifugus* hibernating at this site have since evolved an increased resistance to Pd infections, and it is now recovering from WNS. Another field study at this mine complex has also revealed that big brown bats (*Eptesicus fuscus*) have always been resistant to Pd infections, and do not suffer from WNS. Studies on the wing skin (epidermis) of both Pd-resistant *M. lucifugus* and *E. fuscus* have revealed that this resistance is

due, at least in part, to the accumulation of linoleic acid in the outer epidermis. Linoleic acid is a polyunsaturated fatty acid that cannot be synthesized by mammals and must be obtained through the diet. The goal of this study is to determine the species of insects consumed by this bat species that provides them with the greatest amount of linoleic acid in their diet.

Jackson, Allyson | *SUNY Purchase* | "Pilot study of emergent aquatic insect subsidies in Black Rock Forest"
Abstract: As an ecologist, ornithologist, and ecotoxicologist, I'm very interested in the connection between aquatic and terrestrial ecosystems and how they impact the riparian songbird community. Long term, I'm very interested in building a research program in Black Rock Forest that looks to understand the connection between ecosystems. In this pilot study, I would like to start by first understanding the aquatic invertebrate community at a variety of sites within Black Rock Forest. By also collaborating with the national Dragonfly Mercury Project, this pilot study will provide important information about mercury levels in aquatic invertebrates in the forest while also providing data to the larger nationwide monitoring study. In the future, I hope to use this information to understand which water bodies are of primary concern for mercury exposure and focus my future sampling efforts there.

Macey, Suzanne and **Palmer, Matthew** | *American Museum of Natural History* and *Columbia University* | "High-resolution tracking of rare turtles at Black Rock Forest: Development of new tools for wildlife conservation"
Abstract: In the past 50 years, the technology for fine-scale wildlife tracking has evolved to be more precise, affordable, and automated. Leveraging a new partnership with the Wildlife Movement Institute, new funding from the American Museum of Natural History's Center for Biodiversity and Conservation, and preliminary research from 2019-2022, we propose to 1) test new LoRa technologies and achieve automation of data retrieval from GPS backpacks through the Wireless Mesh Network at Black Rock Forest and 2) expand the collection of tracking data on multiple turtle species in Black Rock Forest, which will allow for both ecological and technological comparative studies. We intend this study to be a collaborative and coordinated effort and expect the process to inform management, educate young scientists, and shape ongoing and future research at Black Rock Forest and other institutions.

Millena, Rebecca J.A. and **Ware, Jessica** | *American Museum of Natural History* | "Surveying Strepsiptera: testing collection methods for the twisted-wing parasites"
Abstract: The twisted-wing parasites (Strepsiptera) are an order of insects that have puzzled entomologists for centuries. One of the biggest obstacles in their study is their perceived rarity—they are minuscule (less than 5 mm large), live most or all of their lives within their hosts, and can exist at low levels in their host populations. The biological and ecological complexity – specifically, the extreme sexual dimorphism – displayed in the group also pose a problem to their study. Many species are described only from male specimens, since the wingless females never leave their hosts' abdomens. Even then, males are short-lived and easily overlooked. This project seeks to evaluate collection methods of Strepsiptera in Black Rock Forest and record the strepsipteran species collected there, thereby providing essential baseline knowledge for the study of these organisms and establishing Black Rock Forest and environments like it as productive collection sites.

Pereira, Kathleen Aria Carreras | *Columbia University* | "How does the plant neighbor of a red oak seedling affect its mycorrhizal colonization status?"
Abstract: As climate change-induced temperatures increase, it is predicted that tree range shifts will occur by expanding northwards, with the implication that temperate forests will shift into former boreal forest ranges. With northward migration, we expect to see new neighboring tree interactions as arbuscular mycorrhizal

(AM) associated trees enter ectomycorrhizal (EM) dominant stands. What are the implications for dual-colonist seedlings such as *Quercus rubra* which can associate with both mycorrhizal guilds as they establish in AM- or EM- dominant vs mixed stands? In this experiment, I propose to evaluate the biotic effects of varying neighbor plant species in the establishment and mycorrhizal colonization of *Quercus rubra* seedlings. This work would aid understanding of fundamental biology and community ecology and can provide guidance in forest restoration projects as stand mycelial networks and seedling mycorrhizal colonization are evaluated for increased success in establishment. This would also be useful in predicting plant-plant mycorrhizal interactions during climate-mediated species range shifts.

Reinmann, Andrew and **Boston, Brian** | *City University of New York - Advanced Science Research Center* | "Integrating dendrochronology with airborne remote sensing to support practitioner efforts in monitoring and managing hemlock decline"

Abstract: Eastern Hemlock (*Tsuga canadensis*) is a coniferous tree species native to Eastern North American forests. The deep shade it casts and its capacity to produce self-perpetuating conifer stands in landscapes otherwise dominated by deciduous trees creates unique habitat and microenvironment conditions that make it an important foundation species. Unfortunately, eastern hemlock is in decline across a growing portion of its range because of the Hemlock Woolly Adelgid (*Adelges tsugae*) (HWA), an invasive sap-sucking insect native to Japan that was first detected in the U.S. in 1951. As such, HWA is a key management and conservation concern of researchers and practitioners. Fortunately, progress is being made in testing biological controls of HWA, but there is a dire need for practitioner-friendly tools to assist with (1) locating appropriate stands for deployment and (2) assessing the efficacy of these controls. Remote sensing products can provide opportunities to assist practitioners and complement their field surveys which although effective are limiting and resource intensive. However, the specialized training needed to run existing remote sensing models developed by researchers coupled with the often high cost of data products has precluded implementation by practitioners. Since 2021, we have been working with researchers and practitioners to develop a cost-effective, user-friendly remote sensing model that uses high spatial resolution and freely-available orthoimagery with the goal of aiding practitioners in the early detection and tracking of hemlock decline (and recovery). Critical to the development of this model is connecting the remote sensing model output with tree-scale physiological processes. HWA has been at Black Rock Forest for several decades, causing moderate to advanced states of decline in hemlocks and providing the ideal location to test a key question: To what extent do temporal patterns of decline detected with our remote sensing model actually match temporal patterns of tree decline? We propose to use dendrochronology analyses of hemlock trees in varying states of decline across Black Rock Forest to quantify correlations or hysteresis in the timing of tree growth decline and declines in canopy health as determined from remote sensing analyses. This work will produce three important data products: (1) a ground-validated remote sensing model for detecting hemlock decline, (2) maps of spatiotemporal patterns in hemlock decline across Black Rock Forest, and (3) datasets for assessing some of the roles site conditions play in mediating rates of hemlock decline following infestation. In addition, this work will provide the foundation to assess hemlock recovery should HWA control measures be implemented. We expect this work to result in one publishable manuscript and a new dataset that provides the basis for a larger grant proposal to finalize development of our model.

2022

Alveshere, Brandon, Fahey, Bob and **Reinmann, Andrew** | *University of Connecticut* and *City University of New York - Advanced Science Research Center* | "Evaluating relationships among edge forest context, structure, and function"

Abstract: Edge creation associated with anthropogenic activity is a pervasive feature of contemporary landscapes with relevance to forest productivity and the global carbon cycle. Edge forests make up a

substantial proportion of the northeastern US forest area, with over one-fifth of forest area occurring ≤ 30m from agricultural or developed edges. Edge forests exhibit altered ecosystem function and modified canopy structure. Evidence broadly suggests that canopy structure of edge forests plays a major role in edge functioning, including forest productivity and carbon cycling, through effects on microclimatic gradients and resource capture and use; however, the specific structural changes underlying these relationships are not well understood. Edge contextual traits such as adjacent land-use and edge orientation further influence edge structure and function and may partly drive development of distinct edge structures and typologies. Furthermore, the temporal aspect of edge canopy structural development in response to edge creation, especially under different contexts, has not been thoroughly characterized. A generalized framework is needed to elucidate mechanisms that underpin these relationships, as well as the temporal context of edge development. Here we propose a paired observational-manipulative experiment to evaluate mechanisms linking edge structure to function under a variety of landscape contexts. The proposed work leverages paired remotely-sensed measures of edge and canopy structure with field-measured proxies for edge function, and will result in development of a novel framework for evaluating edge canopy structure and its variation, as well as a set of newly created edges at which we will characterize and track structure and function over time. Results will promote understanding of edge structure-function linkages related to productivity and the global carbon cycle, as well as their development over time. These findings will inform management focused on manipulation of edge canopy structure, ecosystem function, and infrastructure resilience.

Davidson, Kenneth | *Brookhaven National Laboratory* and *SUNY Stonybrook* | "Moving from leaf to canopy: An analysis of mechanisms regulating seasonal dynamics of stand scale water use efficiency in eastern deciduous forests"

Abstract: Understanding the physiological and structural mechanisms which regulate canopy gas exchange is an essential aspect of forest conservation science, as canopy gas exchange plays an important role in ecosystem hydrology, carbon flux, and energy balance. Seasonal variation in stomatal response to photosynthesis leads to a range of leaf level water use efficiency (WUE), and seasonality in canopy structure and albedo leads to dynamic within-canopy meteorology and latent heat flux. Despite the fact that variation in WUE and canopy structure directly impact local carbon and water cycles, lack of knowledge regarding dynamics in these parameters remains one of the largest uncertainties in current model predictions of the functioning of North American forests, with almost no studies addressing a mechanistic link between seasonality and dynamics of WUE. I plan to close this knowledge gap by installing an autonomous sapflux measurement network at the Black Rock Forest which will enable monitoring of seasonality in transpiration. These data, when combined with UAS derived estimates of forest stand structure and photosynthetic seasonality, will enable an evaluation of the core mechanistic drivers of seasonal variation in WUE. This improved understanding of seasonal forest function can be translated into conservation actions, such as targeted protection of the most vulnerable species, directed outplanting campaigns, and precision extirpation of unwanted invasive species.

Hughes, Kim | *Fordham University* | "Genetic connectivity for mammal populations in Black Rock Forest and the effect of anthropogenic barriers at a small scale"

Abstract: Roads are an important source of ecological disturbance in anthropogenic landscapes. This effect can be all the stronger when considering species that occur at lower densities. This project seeks to examine the extent of the role of roads in influencing the genetic connectivity of several mammal species including larger carnivorans on a small scale. It will be driven primarily by non-invasive sampling via scat, which will be used for a genetic analysis of differentiation within the landscape of Black Rock Forest. This work will lay the groundwork for potential mitigation strategies, such as road crossings, and provide BRF with baseline data on genetic connectivity in the top trophic level.

Tolman, Ethan and **Ware, Jessica** | *American Museum of Natural History* | "Using Genomics and Traditional Methods to Assess the Odonata of Black Rock Forest"

Abstract: Despite the utility of Odonata as bioindicators of aquatic habitat, a comprehensive assessment of the Odonata of Black Rock forest has not yet been completed. Here, I propose to opportunistically sample for the Odonata of Black Rock Forest with both aerial and aquatic nets to capture adults and immature stages. I will also sequence the genomes of the Dragonhunter (*Hagenius brevistylus*, family Gomphidae) and the Lancet Clubtail (*Phanogomphus exilis*, family Gomphidae) to model how these species of Odonata have faired in the past, and predict their success in the future. This project will result in two high-quality reference genomes, published as a genome-note in a peer reviewed journal, an inventory of the Odonata of Black Rock Forest published (also published in a peer reviewed journal), and in an educational brochure for patrons of the forest.

2021

Bruner, Sarah | *Columbia University* | "The portfolio effect in forests: linking tree diversity to forest function"

Abstract: This grant would fund wireless capability for sensors installed during 2019 and 2020 in the Future of Oak Forests experiment, enabling streaming of real-time data for research, education, and outreach opportunities. The work examines the effect of tree diversity on forest carbon accumulation and ecohydrology and leverages the unique manipulative experiment to unravel the mechanistic underpinnings of diversity's effect on the stability of these ecosystem functions, a theoretical contribution to ecology and practical one to the conservation of northeastern forests. As the species composition of the world's forests is changing due to extinctions, novel species interactions, patterns of disease, and climate, understanding how shifts in community structure will alter the stability of forest services is crucial to the preservation and valuation of our forests.

Cox, Rachel | *Riverdale Country School* | "Epigenetic and Physiological Variability in a Pine Forest Community"

Abstract: Epigenetic analysis represents a novel approach to issues of environmental conservation. Phenotypic variability provides individuals with appropriate response patterns in the face of rapid environmental challenges such as those encountered by climate change. Often utilized in the plant kingdom, epigenetic modification represents a rapid and transient mechanism for adaptation. During previous research in Black Rock Forest, we showed that individual members of the Picea spruce forest community display differential epigenetic profiles. These data suggest that even within the confines of a small forest, mechanisms controlled at the epigenetic level may play important, variable and potentially predictable roles on adaptive response. This proposal aims to extend and refine our initial research by probing questions of variable epigenetic adaptation between and within individual trees at Black Rock Forest. Here we propose experimental questions that would address both metabolic as well as epigenetic response. This research will provide an important model for larger scale studies involving this species and others in Black Rock Forest as well as in ecosystems such as the arctic that are vulnerable to rapid fluctuations due to climate change. Finally, since epigenetic modification may provide an essential link between environmental change and phenotypic plasticity in wild populations, results of our study could contribute to important issues in conservation ecology.

Davidson, Kenneth | *Brookhaven National Laboratory* and *SUNY Stonybrook* | "Evaluating patterns and drivers of leaf water use efficiency with ontogeny in eastern deciduous forests of New York state"

Abstract: The physiology of stomata is a critical area for forest conservation science, as stomata play a dual role in limiting water loss via stomatal conductance (gs) and allowing for CO2 entry into the leaf for use in photosynthesis (A). Variation in stomatal response to photosynthesis leads to a range of water use efficiency (WUE) among genotypes, species, and regions. Despite the fact that WUE directly impacts global carbon and water cycles, lack of knowledge regarding dynamics in WUE remains one of the largest uncertainties in current model predictions of the functioning of North American forests, with almost no studies addressing how WUE shits with leaf ontogeny. I plan to leverage the diversity of eastern deciduous forest trees at the Black Rock Forest Conservancy to aid in understanding if, how, and why leaf level WUE shifts with seasonal leaf ontogeny. Understanding of intraspecific dynamics in WUE, as well as the physiological, anatomical, and abiotic factors which drive these dynamics will allow for better predictions of how the forest will respond to climate change, which can be translated into conservation actions, such as protecting vulnerable species, targeted outplanting campaigns, and precision extirpation of unwanted invasive species.

Macey, Suzanne and **Palmer, Matthew** | *American Museum of Natural History* and *Columbia University* | "High-resolution tracking of rare turtles at Black Rock Forest: Development of new tools for wildlife conservation"

Abstract: In the past 50 years, the technology for fine-scale wildlife tracking has evolved to be more precise, affordable, and automated. Leveraging new tracking technologies and preliminary research from 2019 and 2020, we propose to 1) to improve existing GPS tracking technology ("backpacks") and 2) test new technologies and advance towards automation of data retrieval from the backpacks to the Wireless Mesh Network at Black Rock Forest 3) continue to collect ecological data on turtle species in Black Rock Forest. We intend this study to be a collaborative and coordinated effort and expect the process to inform management, educate young scientists, and shape ongoing and future research at Black Rock Forest and other institutions.

Peregrin, John | *Columbia University* | "Multilevel assessment of Eastern hemlock growth: Dendrometers, tree cores, field methods and chlorophyll/carotenoid index"

Abstract: The hemlock wooly adelgid (*Adelges tsugae* Annand) (HWA) causes the fatal decline of eastern hemlock (*Tsuga canadensis* (L.) Carr.) manifested through a decrease in growth rate. Untreated and proposed treated hemlocks at Black rock forest and untreated and prior treated hemlocks at Mianus River Gorge would be selected for growth assessment. Together with the field methods of branch tip sampling and visual crown ratings as well as tree cores, HWA infestation history and severity and hemlock health can be classified. Dendrometers attached to field-measured hemlocks can produce signals of intra-annual growth rate. This growth rate, calibrated with tree classification for HWA treated and untreated trees, can test the correlation strength between levels of HWA and growth, as well as the response to infestation and treatment. These measurements are spatially limited unless they can be scaled with remote sensing. The chlorophyll/carotenoid index (CCI), available through satellite spectral analysis, has been shown to correlate with dendrometer growth rates on other needle leaved trees. If this CCI-growth rate relationship can be shown in hemlocks it could be used for HWA early detection to manage their spread through the northern extent of the hemlock range.

Soccorsi, Anna and **LaPoint, Scott** | *Columbia University* and *Black Rock Forest* | "Gray fox distribution, occupancy, and relative abundance within Black Rock Forest and the surrounding landscape"

Abstract: Human land use changes affect wildlife population viability globally, especially carnivores. Gray fox (*Urocyon cinereoargenteus*), a forest-dwelling mesocarnivore in North America, exhibit variable responses to human-dominated landscapes, possibly due to complex relationships with co-occurring carnivore species. Using camera trap surveys, we will quantify gray fox occupancy, distribution and relative abundance in peri-urban and suburban areas within and surrounding Black Rock Forest (BRF), including assessing the role four co-occurring carnivores play in each metric. This study will extend BRF's carnivore distribution survey by expanding to new survey areas, targeting a thus far rarely documented carnivore, and providing rigorous spatio-temporal analyses into the factors driving gray fox space use, including their predicted use of riparian corridors.

2020

Akana, Palani | *Columbia University* | "How does an invasive nitrogen-fixing tree affect the spatial distribution of soil nitrogen, tree access to soil nitrogen, and seedling growth?"
Abstract: An invasive nitrogen-fixing tree, *Robinia pseudoacacia*, is likely to become more abundant in Northeastern forests such as Black Rock Forest as the climate warms, with important implications for nitrogen cycling and the conservation of native forest species. Soil nitrogen availability is an important control on tree growth in temperate forests, yet most studies ignore the fact that plant-available soil nitrogen is highly variable in space and time and tends to be concentrated in hotspots. This spatial variation is especially critical for trees in their seedling and sapling phase, since small rooting distributions can restrict access to essential nutrients like nitrogen. I plan to study the spatial distribution of soil nitrogen availability in forest plots with and without *Robinia* trees and investigate how seedling and sapling access to soil nitrogen through root uptake is affected by the size of a plant and the presence of *Robinia* trees.

Bruner, Sarah | *Columbia University* | "The portfolio effect in forests: linking tree diversity to forest function"
Abstract: This grant would fund travel to and from Black Rock Forest for the continuation of work from my 2019 grant examining the effect of tree diversity on forest carbon sequestration and ecohydrology in the Future of Oak Forests experiment. The study leverages this unique manipulative experiment to unravel the mechanistic underpinnings of the relationships between biodiversity and ecosystem function, a contribution both to ecology and the conservation of northeastern forests. As the species composition of the world's forests is changing due to novel species interactions, patterns of disease, and climate, understanding how shifts in community structure will alter forest services such as carbon accumulation and water cycling is crucial to the preservation and valuation of our forests.

Deas, Ayo and **Reinmann, Andrew** | *City University of New York - Advanced Science Research Center* | "Leveraging natural gradients in microenvironment to interactive effects of changes in climate and forest tree species composition"
Abstract: Forest ecosystems play a key role in the global carbon (C) cycle and currently sequester more than a quarter of anthropogenic carbon dioxide emissions to the atmosphere each year. The capacity of forests to sequester C into the future hinges upon their response to the multitude of environmental changes confronting these ecosystems. Here, we propose to build on an existing environmental gradient study at Black Rock Forest and integrate forest micrometeorological measurements with high temporal resolution tree growth measurements to develop robust predictive relationships between climate conditions and tree growth. In alignment with the mission of the Virtual Forest Initiative at BlackRock Forest, this research can open numerous pathways for inner-city youth to become exposed to landscapes that may have otherwise been

foreign to them. Dendrochronology at BlackRock Forest provide access to expand the curricula and advancement of New York City STEM education.

Macey, Suzanne and **Palmer, Matthew** | *American Museum of Natural History* and *Columbia University* | "High-resolution tracking of rare turtles at Black Rock Forest: Development of new tools for wildlife conservation"

Abstract: In the past 50 years, the technology for fine-scale wildlife tracking has evolved to be more precise, affordable, and automated. Leveraging new tracking technologies and preliminary research from 2019, we propose to 1) to survey for Eastern box turtles within Black Rock Forest, 2) obtain a more complete field season of movement and ecology data, 3) add temperature sensing and logging capabilities to DIY GPS backpacks, 4) make advancements towards automation of data retrieval from the backpacks to the Wireless Mesh Network currently being installed at Black Rock Forest. We intend for this study to be a collaborative and coordinated effort and expect the process to inform management, educate young scientists, and shape ongoing and future research at Black Rock Forest and other institutions.

Mifsud, Isobel | *Columbia University* | "Quantifying rates of Nitrogen fixation in xylophagus beetle larvae"

Abstract: Xylophagus beetles consume wood as their primary food source. However, wood is very low in nitrogen, which is a key nutrient for growth and development. In this study, I intend to investigate alternative strategies of nutrient acquisition by sampling xylophagus beetle larvae from decomposing wood at Black Rock Forest, and testing for nitrogen fixation activity by associated gut bacteria using a combination of acetylene reduction assays and stable isotope analysis. I also hope to establish whether N fixation activity correlates with wood N content.

Taylor, Benton | *Harvard University* | "How drivers of the forest understory shift between biotic and abiotic controls based on deer browsing and oak mortality"

Abstract: Human-mediated forest disturbance, such as rising rates of plant disease transmission and increases in deer densities, can have dramatic impacts on forest structure and community composition. However, we have a relatively poor understanding of how multiple drivers of disturbance interact to determine forest regeneration dynamics. Here, I propose to utilize the existing deer exclosures in the Future of Oak Forests experiment to determine how deer browsing interacts with the effects of simulated canopy disease mortality to determine the regeneration dynamics of the understory at Black Rock Forest. A team of student research assistants and I will measure abiotic factors such as light, leaf litter biomass, soil nitrogen and phosphorus, and asymbiotic nitrogen fixation inside and outside of the deer exclosures in the Future of Oak Forests experimental plots. We will pair these measurements with a census of the understory vegetation (biomass, diversity, and species functional traits) to determine how canopy mortality and deer browsing interact to shift understory vegetation dynamics between biotic and abiotic controls. Results from this work will provide valuable information to land managers on the potential effects of deer control in areas exposed to large-scale canopy tree diseases.

2019

Bruner, Sarah | *Columbia University* | "The portfolio effect in forests: linking tree diversity to forest function"

Abstract: The species composition of the world's forests is changing due to novel species interactions, patterns of disease, and climate. As biodiversity directly influences ecosystem function, shifts in community structure will alter forest services such as carbon accumulation and water cycling. Using Black Rock Forest's

(BRF) Future of Oak Forests experiment, I will examine the effect of tree diversity on forest carbon sequestration and ecohydrology by estimating carbon accumulation and water use efficiency. This study will leverage BRF's unique manipulative experiment to unravel the mechanistic underpinnings of relationships between biodiversity and ecosystem function, a contribution both to ecology and the conservation of northeastern forests.

Cox, Rachel | *Riverdale Country School* | "Epigenetic adaptation in *Picea* spruce"
Abstract: Epigenetic response, especially induced by environmental factors, is recognized as an important component in growth and adaptation across species. Arctic *Picea* spruce experience well-documented environmental stress due to harsh climatic conditions and rising temperatures. Our two-year study of Arctic *Picea glauca* (white spruce) assessed global epigenetic differences across a latitudinal transect ranging from the northernmost point of spruce existence through the more verdant boreal forest. Our pilot studies included Picea from the southernmost region of this species in Black Rock Forest, New York. Conifers serve as ideal models for environmentally induced epigenetic adaptation since mature leaves are exposed to multiple years of frigid temperatures, wind stress and herbivory. Our initial analysis demonstrates that global DNA methylation changes in old growth leaves as a function of latitude and this trend persists through the southern reaches of the species at Black Rock Forest. These preliminary findings indicate a potential epigenetic-driven learning mechanism, potentially a response to environmental stressors. This proposal aims to monitor epigenetic adaptation across this widely distributed conifer species, with Black Rock trees as representatives of the southern population. Information generated by these studies will help to better understand adaptation in conifers and this information could help inform future forest conservation decisions.

Dombroskie, Jason and **Eisman, Charles** | *Cornell University* | "Lepidoptera diversity survey of Black Rock Forest"
Abstract: The Lepidoptera (moths and butterflies) are incompletely known in New York and are vital components to healthy ecosystems. As part of a larger survey across New York, we propose to sample the lepidopteran diversity through light-trapping, diurnal collecting, pheromone trapping, and rearing of leafminers. Annual updates of species encountered and collected will be supplied to Black Rock Forest.

Macey, Suzanne and **Palmer, Matthew** | *American Museum of Natural History* and *Columbia University* | "High-resolution tracking of rare turtles at Black Rock Forest: Development of new tools for wildlife conservation"
Abstract: In the past 50 years, the technology for fine-scale wildlife tracking has evolved to be more precise, affordable, and automated. In this project, we propose to systematically test and pilot three (or four) tracking technologies that may be compatible with the wireless mesh network currently in development at Black Rock Forest (BRF). We will use rare terrestrial and semi-aquatic turtles as our study system allowing us to uncover previously unknown abundances, distributions, and movements of these understudied species at BRF. We intend for this study to be a collaborative and coordinated effort between many research groups and expect the process to inform management, educate young scientists, and shape ongoing and future research.

Reid, Brendan | *Michigan State University - Kellogg Biological Station* | "Using environmental DNA to quantify distributions, habitat associations, and potential dispersal routes for turtles in the Black Rock Forest region"
Abstract: Black Rock Forest is home to a number of turtle species, including several rare species of conservation concern. These species are cryptic and rarely observed in the forest, and as such their distributions and abundances are poorly known. I propose to use environmental DNA to conduct a survey of

the spatial distribution of turtle diversity in Black Rock Forest, and to use the results of this survey to identify species-specific environmental associations and effects habitat change, as well as potential dispersal routes for each species. This work will enhance our understanding of Black Rock's fauna and facilitate conservation of these sensitive species.

Reinmann, Andrew | *City University of New York - Advanced Science Research Center* | "Leveraging natural gradients in microenvironment to interactive effects of changes in climate and forest tree species composition"

Abstract: Forest ecosystems play a key role in the global carbon (C) cycle and currently sequester more than a quarter of anthropogenic carbon dioxide emissions to the atmosphere each year. The capacity of forests to sequester C into the future hinges upon their response to the multitude of environmental changes onfronting these ecosystems. The proposed research will use dendrochronology to link field-based observations of forest growth at Black Rock Forest and satellite-based remote sensing metrics of forest health to leverage (1) natural gradients in microclimate and tree species composition and (2) interannual variations in climate conditions to advance understanding of forest response to changes in climate and forest composition. In alignment with the mission of the Virtual Forest Initiative at BlackRock Forest, this research can open numerous pathways for inner-city youth to become exposed to landscapes that may have otherwise been foreign to them. Dendrochronology at BlackRock Forest will provide access to expand the curricula and advancement of New York City STEM education.