

## **2020: A tumultuous but productive year in the Bozeman Disease Ecology Lab**

2020 has been a unique and challenging year for all of us, and it has been a busy one for us here at the Bozeman Disease Ecology Lab. Here are some highlights of our year:

### **Dr. Plowright - Principal Investigator**

After spending our careers focused on research to prevent pandemics of bat origin, we found ourselves responding, in real-time, to a pandemic of bat origin. As the pandemic grew exponentially throughout January, we watched in shock. In late January, while checking my phone at the crowded Dhaka airport in Bangladesh, I learned that SARS-CoV-2 could be transmitted asymptotically. That was a turning point in our understanding of this new pathogen and I immediately donned the N95 mask the Bangladesh field team had given me for my travel home. A few days later, the Bangladesh team relinquished their entire N95 supply to local hospitals. Without adequate PPE (absolutely necessary when doing field work on bat pathogens), and with increasing local travel restrictions, our Bangladesh field work was halted. Then, one-by-one, our Bat One Health field programs were closed--Madagascar, Ghana and Bangladesh. The only location that sustained bat sampling throughout the pandemic was Australia. However, even in Australia, our field work was disrupted by state border closures and this affected a student's ongoing bat movement studies. The Australian international border closures also prevented us from moving US-based field team members to help over the Austral winter (see Brooklin's update).

One of the hardest impacts of the pandemic was the delay in export and transit of samples. Some students had 4-6 month delays before receiving samples, and then the shortages of lab supplies imposed further delays that have been devastating to PhD students. Moreover, team members have been affected by kids at home with daycare and school closures. The team coped amazingly well considering the toll on student time-lines. As a testament to the resilience of the team, when lab work was not possible, the students found new opportunities, like helping with the pandemic response.

Given the lab is full of students and postdocs with higher degrees in epidemiology, public health, and disease ecology, we became a unique resource in Montana. The lab got involved in many

aspects of the response to the COVID-19 pandemic – for example, we created a blog (see here: <https://www.montana.edu/diseaseecologylab/covid19blog/>) to inform the general public about the science behind pathogen transmission and control; Manuel and I rewrote my Disease Ecology course to be entirely on the COVID-19 pandemic and then delivered this to 60 super-engaged graduate and undergraduate students at MSU; we created dynamic models of SARS-CoV-2 transmission to inform public health policy on campus; and we contributed to local public health efforts. Many lab members helped develop testing plans for the Montana University System for fall and spring. More recently, in collaboration with faculty in engineering and microbiology, we developed a plan for high-throughput, high-frequency testing of students on campus (using LAMP). We still hope the university leadership will implement this plan in the spring.

In addition to these local tasks, we have been working on developing the scientific basis of pandemic prevention to stop the next pathogen emerging from bats. We have a number of major papers on henipavirus spillover on the verge of submission and many papers on henipavirus dynamics in bats, including strategies to prevent spillover, in progress. These papers are the culmination of many years of intensive field work in a number of locations. We also worked on a series of papers on land use-induced spillover (e.g., pre-print DOI: [10.32942/osf.io/cru9w](https://doi.org/10.32942/osf.io/cru9w)) and land management strategies (e.g., pre-print DOI: [10.32942/osf.io/7gd6a](https://doi.org/10.32942/osf.io/7gd6a)) to minimize zoonotic disease transmission (see Publications page for a full list of preprints). The Global Landscape Forum (GLF) and World Bank engaged us to provide advice on landscape management to prevent zoonotic spillover and we gave a plenary on these concepts at the GLF. Undergraduate Brooklin Hunt made a video that was featured at the GLF and she joined me in the panel of experts at the end of the session. I spent a lot of time communicating with the media to facilitate public literacy of science--from local papers on wearing masks (when it was still controversial), international press on the likely origins of COVID, to how to prevent the next pandemic (see lab Media page for a full list). Many lab members engaged with the media over the course of the pandemic, and they were featured in films, TV documentaries, and educational series. I'm particularly looking forward to seeing us all dubbed in French when the French equivalent of BBC air their episode on our bat virus work!

### **Maureen Kessler - PhD Student**

As the year comes to a close, I am wrapping up my PhD chapter on flying fox movement, where I evaluated how changes in diet and foraging behavior might increase risk of Hendra virus spillover. I also spent much of 2020 coordinating a fecal metabarcoding study of flying fox diets with collaborators at Griffith University and a study on fecal glucocorticoids at Montana State University, both of which are expected to start early 2021. Other work in 2020 includes contribution to a project modelling high-throughput surveillance strategies for COVID-19 control at MSU and more broadly (manuscript led by undergrad Will Rogers) and contribution to a large collaborative review of coronaviruses in bats. I also continue to enjoy mentoring other undergraduate extraordinaires Brooklin Hunt, Lindsey Lee, and Dale Hansen as they work on their independent student projects. Year highlights were the Sidney Manton Award, given to Dan Becker for a paper that I co-authored and others in the *Journal of Animal Ecology* ("Macroimmunology: The drivers and consequences of spatial patterns in wildlife immune defence"), as well as two conference and workshop travel awards. In my free time, I skied off the ridge at Bridger Bowl for the first time, crashed my mountain bike, and planted an excessively productive vegetable garden.

### **Dan Crowley - PhD Student**

In 2020 I published "Identifying Suspect Bat Reservoirs of Emerging Infections" in the journal *Vaccines*. I, with the help of Wyatt Madden, made progress on applying shrinkage machine learning methods to the phylogenetic analysis tool Phylofactor. With the help of Caylee Falvo, I also worked on developing a new assay to assess the *Pteropus* bat's humoral immune system, including work to characterize the first bat IgM.

### **Caylee Falvo - PhD Student**

I spent 2020 working with Dan Crowley and the Apple Lab to develop assays to measure immunoglobulins. We have also been measuring cytokines using qRT-PCR and several blood proteins that may reflect the health status of the bats.

## **Troy Koser - PhD Student**

I started the year hitting the ground running by planning for moose captures in Jackson, Wyoming, in February/March that would serve as the first pilot study on winter tick-related health impacts for the herd. In April I helped start up a Montana COVID-19 blog that ran through the summer as well as organized a workshop discussing moose-disease research in North America with specific emphasis on ongoing winter tick studies. Over the summer I planned a winter tick ecology study out in Jackson Hole, the first study of its kind in the Rocky Mountain West, then spent August-October and much of November in the area collecting ticks and recording habitat, microclimate, and host factors associated with their activation and distribution (see photo). We started a project with Working Dogs for Conservation ([link to website: https://wd4c.org](https://wd4c.org)) to determine if dogs could detect winter ticks on the landscape, which to our knowledge is the first time working dogs will be used to find ticks.



PC: Zach Andres

### **Devin Jones - PhD Candidate**

This year, I completed my troubleshooting for DNA extraction from my bat fecal samples, and am now waiting on backordered lab supplies before I can finish lab work. This summer, I contributed to the lab's COVID blog and assisted local health officials collate information about COVID. I'm currently working on a meta-analysis on bat microbiomes with collaborators.



### **Trenton Bushmaker - Master's of Science Student**

2020 has been a seesaw of emotions, at the start of 2020 I was able to join the powerhouse Bozeman Disease Ecology Lab. However, since January I had to pivot my focus from the initial proposed Hendra project to work relating to the SARS-CoV-2 pandemic. For the year 2020 I was able to produce (2) co-first author manuscripts in New England Journal of Medicine for the stability of SARS-CoV-2 (in relation to my thesis) and in PLOS pathogens regarding a severe mouse infection model for SARS-CoV-2. In addition, I was able to provide scientific support for an additional 8 manuscripts for co-author status including the initial publication for the ChadOx1 nCoV-19 vaccine in Nature (DOI: <https://doi.org/10.1038/s41586-020-2608-y>).

### **Dale Hansen - Undergraduate Researcher**

This year I developed a diet analysis project which will start when samples arrive from Australia. Over the summer, I contributed to the lab's COVID testing program development efforts, and I am currently working on the manuscript for COVID-19 control via high throughput surveillance testing strategies. I spent the past semester researching the efficacy of the surveillance testing strategies of various universities nationwide to help inform decisions surrounding the use of a LAMP assay for COVID testing at MSU this spring. I am also collaborating with Brooklin Hunt on a hematology study which we hope will provide a set of normal hematological parameters for healthy adult black flying foxes.

### **Brooklin Hunt - Undergraduate Researcher, Laboratory Manager/Technician**

2020 has been a whirlwind of lab work and unexpected changes due to the current pandemic. Originally, I was set to leave for a 15-month Study Abroad and research project with our collaborators in Australia in May. When we realized COVID-19 was shutting down international travel, I attempted to leave early in March, but the Australian border closed just 3 days before I was scheduled to leave! With the border closed and all of the fecal samples I needed for my diet ecology study unavailable (also because of COVID-19), I ended up instead leading a study on the hematology of black flying foxes with Dale Hansen. Aside from this, I also wrote for the Lab's COVID-19 blog, presented to roughly 700 people worldwide through 6 different research presentations, took on the position of Lab Manager and Technician, and contributed to a paper (pre-print DOI: [10.32942/osf.io/7gd6a](https://doi.org/10.32942/osf.io/7gd6a)) on landscape immunity with Dr Plowright and other collaborators. For a few months I was also involved in a project with the Bimczok Lab where I helped develop a pilot study of canine detection of respiratory pathogens. This project will eventually form the basis of human COVID-19 testing using working dogs in Montana. In my free time, I took a summer class in elephant medicine, hiked in Yellowstone National Park, and adopted a stray kitten!

### **Will Rogers - Undergraduate Researcher**

I was able to submit a manuscript regarding sex-biased transmission and harvest strategies with chronic wasting disease this Fall. I am now working on the manuscript for COVID-19 control via high throughput surveillance strategies and how dynamics of testing and population behavior

affect surveillance efficacy. I am also now working on applying a machine learning model to a large camera trapping dataset from Zambia, aiming to classify a bunch of images and start to generate some inferences about mammal communities and landscape dynamics. Finally, I have been working on the analyses for some bighorn sheep GPS data, trying to answer what types of movements (and risks) that male and female sheep take during the breeding season.

### **Wyatt Madden- Statistician**

I made progress on research in statistical methods for data integration, and helped with the submission of a paper on Hendra spillover. Also, inspired by all the brilliant researchers in our lab, I decided to commit to the pursuit of a PhD.

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A few other major accomplishments made by our members in 2020 include:

- Manuel Ruiz-Aravena was published in Science Magazine (DOI: 10.1126/science.abb9772)!
- Brooklin Hunt and Lindsay Lee were accepted into the McNair Scholars Program at Montana State University
- PhD Candidate German Botto-Nuñez finished his thesis and will defend on January 4th, 2020.
- Will Rogers was the first author on a manuscript (in review) titled “Sex-based differences in disease transmission may affect management efficacy of chronic wasting disease.”
- PhD Candidate Devin Jones was featured on Montana PBS! See the segment here: <https://www.montanapbs.org/programs/rundown/203/>.
- Devin also starred in a video produced by a graduate student, Jordan Lawrence, for a class project in the Film Department here at MSU. See Jordan’s video here: <https://vimeo.com/482468499>. We are excited to continue working with Jordan to produce a longer film about our work in 2021.
- Many of our group members were filmed for a documentary about bat virus research! The documentary is still being produced, but we are all looking forward to seeing it in 2021.

- We had a dress-up lab meeting in March that brought lots of laughs. We had a couple of mystery fishermen and women, a Laurence of Arabia, and a skier from outer space!

Aside from all of these achievements in our research projects, we were also very excited to welcome some new staff members to the Bozeman Disease Ecology team in 2020:

Abby Ayers - Data Entry Employee

Eliza Krause - Lab & Program Manager

Lindsay Lee - Undergraduate Researcher (focused on bat parasitology and hematology)

McKenna Quirk - Undergraduate Researcher (focused on pika parasitology)

Tristen Bennett - Undergraduate Researcher (focused on bat immunology)