Vision - As a global change ecologist, my research explores how a changing planet shapes species distributions. Understanding the ecological and evolutionary forces that dictate range limits are fundamental challenges in ecology and invasion science. Ecological theory posits that species interactions and environmental conditions constrain survival and reproduction, while evolutionary theory emphasizes that adaptation depends on genetic variation but is often reduced during invasions. My research focuses on terrestrial invasive plants and investigates the following questions: (1) How does climate change influence ecological and evolutionary processes driving species invasions? (2) What ecological and evolutionary factors drive rapid changes in species' distributions, and how can we develop more accurate tools to predict range shifts with climate change? (3) How do models that incorporate species' adaptive potential change forecasts of invasion risk in the context of global change?

Climate change and species invasions – Climate change forces plant populations to adapt or migrate. A key question in invasion ecology is how climate change impacts the establishment and spread of invasive species. My research examines how simulated future climate conditions affect plant fitness, and in turn, affects geographic distributions. In a common garden experiment, I found that range expansion in leafy spurge (*Euphorbia virgata*) was accompanied by shifts in seed dormancy, highlighting the role of evolution in facilitating invasions (Lake et al., 2023, *Evolutionary Applications*). I also contributed to a long-term reciprocal transplant study for common tansy (*Tanacetum vulgare*) in Minnesota, using rainfall and temperature manipulations to simulate future climate conditions and quantify the strength of local adaptation. These findings aim to enhance species distribution models (SDMs) by accounting for adaptation and improve predictions of range shifts under climate change.

Monitoring population dynamics - Detecting new occurrences, tracking population dynamics, and evaluating management outcomes are central challenges in invasion ecology. Traditionally, this work relies on time-consuming field surveys, but advances in remote sensing have transformed our ability to identify invasive species. I used high-resolution satellite imagery and computer vision to track leafy spurge populations with high accuracy across large landscapes (Lake et al., 2022, *Remote Sensing in Ecology and Conservation*) and over decades (Lake et al., *in prep*). These results led to a USDA-NIFA grant (grant no. 2023-67013-39894) that uses remote sensing to track the long-term population dynamics of leafy spurge across its geographic range and in response to management (biocontrol).

Improving invasion forecasts - Species distribution models (SDMs) predict climatically-suitable habitats but can be inaccurate for rapidly-expanding invasive species because they assume species are in equilibrium with their environment. To address this, my research developed techniques to improve SDM predictions for species undergoing rapid range expansion (Lake et al., 2020, *Diversity and Distributions*). Additionally, I co-authored a study using SDMs that incorporated co-occurring native species as surrogates to enhance predictions of invasive species expansion beyond their current ranges (Briscoe Runquist, Lake, and Moeller, 2021, *Journal of Biogeography*). These approaches provide land managers with refined predictions of habitat suitability. They also help prioritize areas that may require additional monitoring and intervention in rapidly changing environments.

Future Directions - My future research will continue to bridge ecological and evolutionary theory to advance predictive models of invasion. I envision a global change ecology lab that will be a hub for integrating quantitative ecology, geospatial science, and field-based experimentation. At Virginia Tech, I see myself contributing to the Invasive Species Collaborative by leading interdisciplinary projects with undergraduate and graduate students that not only enhance our understanding of invasion ecology but also translate into innovative and effective management practices. I look forward to collaborating across domains to address the complex, interconnected challenges of invasive species and global environmental change.