**<A>Introduction**

* **Biodiversity is declining because of global change causing asymmetry in the loss of biodiversity.**

We live in a world amidst accelerating erosion of resource diversity in ecosystems (Grime 1998, Worm et al. 2006, Srivastava et al. 2012). Anthropogenic disruption to functional interactions within ecosystems alters assemblage, threatens biodiversity, and diminishes resource richness (Camargo et al., 2020; Donoso et al., 2020; Jordano et al., 2007; Lorts et al., 2008; Monteiro et al., 2021; Pigot et al., 2016). Animals play a key role in shaping their ecosystems through fundamental ecological processes such as seed dispersal, changing plant biomass, nutrient recycling, pollination, and physical structure alteration (González-Castro et al., 2019; Hempson et al., 2017; McAfee et al., 2018; Parr et al., 2018). However, due to persistent progression of human activities causing abrupt environmental disruptions via habitat loss or fragmentation, we have created an asymmetric skew in the loss of biodiversity, with extinction of animals at higher trophic levels and lower populations sizes occurring first (Davies et al., 2000; Duffy, 2003) (Cramer et al. 2007). This decline of animal populations and species richness is well documented worldwide and has raised concerns on how this will impact the assembly and sustainability of ecosystems (Powers & Jetz, 2019; Spooner et al., 2018; Wang & Loreau, 2016).

* **Plants importance to ecosystems connected to animals?**

Animal resource availability is considerably affected by plants, making plant communities an influential ecosystem characteristic (Bascompte & Jordano, 2007; Sebastián-González et al., 2020). Plant community assembly and succession is influenced by abiotic (e.g., soil nutrients [Aerts, 1999; Coomes & Grubb, 2000]) and biotic (e.g., seed dispersal [Carlo & Morales, 2016; González-Varo et al., 2013; Levine & Murrell, 2003; Nathan & Muller-Landau, 2000; Olden et al., 2004; Tylianakis et al., 2010) factors. Manipulating these factors creates drastically different plant communities from the same starting points (Bakker, 1998; González-Castro et al., 2019). Due to this variability, recent dramatic anthropogenic shifts to ecosystems have increased the need to study functional interactions within ecological communities for conservation efforts, specifically interactions between seed vectors (i.e., animals that transport seeds) and plant assemblage (Camargo et al., 2020; Emer et al., 2019; García et al., 2018; Monteiro et al., 2021; Morán-López et al., 2019; Ribeiro da Silva et al., 2015).

* **There is increasing concern with seed vectors (e.g., frugivores) because they play a vital role in dispersing seeds in the environment; however...**

The decline of seed vector populations (e.g., frugivores) globally has garnered much attention due to their somewhat contradictory (e.g., see Camargo et al., 2021; Farwig et al., 2017) influence on seed dispersal ~~across landscapes~~ (Jordano et al., 2007; Naniwadekar et al., 2019; Carpenter et al., 2018; Case & Tarwater, 2020; Caves et al., 2013; Mokany et al., 2014; Rumeu et al., 2017). However, many of these studies examine specialized diffuse mutualisms in specific tropical ecosystems (Escribano-Avila et al., 2018; Estrada & Fleming, 1986; Herrera, 1985). Diffuse mutualisms occur when a species is dependent on multiple other species, all of which positively interact; for example, pollination, seed dispersal, and plant protection (Rico-Gray 1993, Zamora 2000, Stanton 2003, Gove et al. 2007). In Nearctic diffuse mutualisms, it is less clear how diminishment of seed vector diversity might influence seed dispersal (Davies et al., 2000, 2004; Herrera, 1985). This is due to tropical and temperate hardwood plant community differences (e.g., plant height, seed structure), which have been documented to influence seed dispersal ranges (XXXX; XXXX). Therefore, perhaps tropical seed dispersal research should not be used to make inferences about diffuse mutualisms worldwide. This underscores the need to study seed dispersal ecology outside the tropics for stronger understanding of available resource effects on diffuse mutualisms. (Escribano-Avila et al., 2018).

* **In diffuse mutualisms with functionally redundant seed disperser assemblages, resource diversity may modulate seed dispersal more than the loss of individual species.**

Resources are defined as a substance or object in the environment required by an animal for growth, maintenance, and reproduction (Borah & Beckman, 2021; Gleditsch et al., 2017; Howe & Smallwood, 1982). A general underlying theme in dispersal ecology is that seeds are dispersed towards resources (XXXX, XXXX) because resource abundance and diversity influence animal behavior and seed deposition sites (Saracco et al. 2004; García et al., 2011; Carpentar et al. 2018; Schupp et al., 2019). However, resource diversity in ecosystems is declining (XXXX) and there is a need to better understand how this impacts diffuse mutualisms. In systems with a lot of functional redundancy (i.e., multiple species share similar roles within the ecosystem), declining resource diversity may have a more robust impact than declining seed vector diversity. We know declines in plant diversity can impair seed dispersal (XXXX), but declines in seed vector (e.g., bird) richness may not have as robust of an effect if there is functional redundancy in most seed dispersal relationships.

Declining bird populations and community richness raise concerns on how decreasing abundance and diversity of seed vectors will impact seed dispersal throughout ecosystems (Camargo et al. 2020, Wesely et al. 2020). We know birds are common and effective seed vectors in terrestrial ecosystems (Howe 1997, Naniwadekar et al. 2019, Subalusky & Post 2019, Whelan et al. 2008, Wotton and Kelly 2012) and that bird size has been linked to seed dispersal distance, highlighting bird richness importance (Godínez -Alvarez et al. 2020). More information is needed on how plant diversity (i.e., seed richness) in communities is impacted by depauperate bird assemblage. Considering birds are prominent seed vectors in temperate forest diffuse mutualisms, we examined how depauperate bird community’s influence the relationship between seed rain richness (dispersal potential) and resource diversity.

This experiment utilized bird feeders as a tool to examine how manipulating the richness of food resources available to bird communities influenced: 1) the richness and observations of birds visiting feeders and 2) the richness and observations of seeds deposited beneath feeders through bird excrement. This model system was selected because bird feeders provide a convenient system to manipulate resource availability, are known to influence bird behavior as resources do, and are ubiquitous in the United States (Cowie and Hinsley 1988, Lepcyzk et al. 2004, Fuller et al. 2008, Galbraith et al. 2015). To represent variation in resources, bird feeders were stocked with varying compositions of seeds, nuts and insects of various sizes and nutritional content. Experiment results were hypothesized to exhibit a positive relationship between resource, bird and seed richness and observations.

Cramer et al. 2007 – Forest fragmentation differentially affects seed dispersal of large and small-seeded tropical trees

Grime 1998 – Benefits of plant diversity to ecosystems: immediate, filter, and founder effects

Grove et al. 2007 – A keystone ant species promotes seed dispersal in a “diffuse” mutualism

Rico-Gray 1993 – Use of plant-derived food resources by ants in the dry tropical lowlands of coastal Veracruz, Mexico.

Srivastave et al. 2012 – Phylogenetic diversity and the functioning of ecosystems

Worm et al. 2006 – Impacts of biodiversity loss on ocean ecosystem services