# Functional Diversity and Benchmarks

While each plant functions differently in an ecosystem context, the degrees of dissimilarity which exist between all species are unequal allowing them to clump together into groups. This observation has given rise to the notion of *Plant Functional Types*, shared attributes which unite similar species, and which bind how they affect ecosystems. Oftentimes, form follows function, and functions are hence referred to as forms. For example, Trees provide large amounts of shade, which in combination with their transpiration lower the temperature of areas. Plant functional types are quite often the easiest form of vegetation data to measure, and accordingly great amounts of work have been conducted on how they affect ecosystem function.

In Western Colorado, five major forms of plant functional types are often used to evaluate range conditions. These forms are: Trees, Shrubs, Grasses, and Forbs (or herbs), and each has been linked to affecting rangelands in multiple ways. Grasses … . , While Shrubs for example .. Accordingly, in nearly all instances a mix of each of these groups, less trees, is best to maintain ecosystem services on BLM Land. In our area which features massive extents of Pinon-Juniper Woodland, trees when present, are included in this mix on ecological sites which they are more capable of surviving on over long periods relative to shrubs.

Semi-arid lands which are utilized as rangelands across the world are experiencing several common issues relating to shifts in the composition of their plant functional types (Archer & Predick (2014), Eldridge et al. (2016), Maestre et al. (2016)) . Namely, decreases in grasses whilst increases in woody species are occurring. In certain areas, the increases - or encroachment of - woody species may be split into encroachment of trees, and the transition to a shrub state in ecological sites which do not support trees.

The current increases in shrub cover relative to the cover of the herbaceous strata, grasses and forbs, are problematic for a variety of reasons. The increase in Trees at mixed grass-shrublands sites may decrease water available to grasses and shrubs but not non-native annual grasses (McIver et al. (2022)), as cattle depend on grasses and wildlife shrubs these decrease the ability of our lands to support either. Increases in shrubs at the expense of perennial grasses and forbs may increase the severity of site level drought (Wilson et al. (2018)), further shrubs and trees may foster higher severity fires (CITE). Increases in shrubs decrease soil stability, allowing increased erosion, increasing DUST ON SNOW, and is an irritant to human breathing (Munson, Belnap, & Okin (2011)). Decreases in perennial grass may reduce competing non-native annuals from overtaking sites Sheley & James (2010), Corbin & D'Antonio (2004), although a diversity of species may be best (Belnap & Sherrod (2008)). A decreases in forbs adversely affect wildlife feeding (CITE). These issues we are currently facing may be compounded in the future by probelms which are only begin to become apparent.

Under the increasingly warmer and drier climates (SECTION XX) multiple concerns regarding the establishment, and persistence of perennial grasses, and their utility as forage are becoming apparent. C3 grasses are likely to become more difficult to establish and persist (Munson, Belnap, Schelz, et al. (2011) Gremer et al. (2015)). The nutronal quality of C3 grasses are expected to decline via nutronal dilution, and C4 grasses generally do not have as high protein quality forage ((**Barbehenn2004?**)).

- declines in forbs, which may fix nitrogen, and declines in soil health may compound issues with increases in C02, decreasing the protein in forage (nutrient dilution) ( (**GRASSHOPPERS?**) PNAS, Soussana & Lüscher (2007) )

While the major functional groups are capable of capturing considerable variation which predicts rangeland responses, they often maintain large amounts of variation with them. And we believe that additional functional groups warrant attention in our area. C3 and C4 grasses as illustrated above have different responses to many environmental cues. ... Sprouting and non-sprouting shrubs differ widely in their responses to wildfire, and site require different post fire management strategies.

Annual and perennial forbs (life cycles), and

# Methods

Non-vascular plants mentioned ....

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