# Noxious Plants

One of the first acts in the life of a plant, as a seed, is to move. Generally seeds travel only short distances, but less common long distance movements are known to occur naturally (Section X.X), and long distance movement occurs regularly via humans. The long distance movement of seeds by humans, in recent history *i.e.* the last couple thousand years, may result in the seed germinating and the population (if any) which results from it surviving for only a few generations (*waif*) (Nesom (2000)). A seed may also produce a population which is able to persist for many generations in the new ecosystem, and even disperse and spread out across their new landscape (*naturalized*); many of these species are readily incorporated into the existing vegetation and do little to alter it (Nesom (2000), Pysek & Richardson (2010)). A subset of these species which are able to naturalize may displace considerable amounts of the plant species already in the landscape, and in so doing alters the composition of species at ecological sites (*noxious*), hence also the functioning of these sites (*invasive*) (Davies (2011), Evans et al. (2001), Pysek et al. (2012), Land Management (n.d.), *and reviewed in* Ehrenfeld (2010), Pysek & Richardson (2010)). That a few species can alter the properties of landscapes is at the core of the Ecological Sites. While all invasive plants are noxious, not all noxious plants are invasive, as can be seen from a number of native species which act as aggressive weeds in disturbed settings and which prevent natural succession.

Noxious and invasive species adversely affect nearly all ecosystem services offered by natural areas, increase fire frequency and intensity, and have enormous economic impacts (*reviwed in* Ehrenfeld (2010), D'Antonio & Vitousek (1992), Duncan et al. (2004), Fantle-Lepczyk et al. (2022), Crystal-Ornelas et al. (2021)). Invasive species at landscape scales have been shown to decrease plant species richness, taxonomic, functional and structural diversity leading to declines in habitat heterogeneity and adversely affecting wildlife (Keeley & Brennan (2012), Ehrenfeld (2010), Klinger & Brooks (2017)). They pose serious threats to the well being of both wildlife, livestock, and humans, via interactions with historic land management alterations, to the fire cycle (D'Antonio & Vitousek (1992), Keeley & Brennan (2012), @). The economic impacts of invasive species include enormous amounts of funds being channeled into their treatment to reduce fuel loads (), treatments to curtail their spread into new areas (), and losses in economic activity e.g. by displacement of grasses more suitable as forage for livestock ().

Most land managers in the Western cold deserts (The Colorado Plateau, Great Basin, and Columbia Plateau) consider noxious annual grasses to pose the greatest challenge towards maintaining ecosystems which allow for multiple uses (Chambers et al. (2009)). Of concern to our office is the increasing adpation of cheatgrass (*Bromus tectorum*), which is already present throughout the field office, towards higher elevation sites (J. T. Smith et al. (2022)). Based on the limited evidence currently available the effect of encroachment of invasive species is of more adverse affect than is attributable to climate change or drought, although synergistic interactions between invasive species and drought still occurr (Clarke et al. (2005), Lopez et al. (2022)).

## Methods

Creation and maintenance of registries of noxious and invasive species often falls on the Department of Agriculture of the Federal and State governments (Quinn et al. (2013)). Given the focus of these agencies, these lists are generally focused on arable lands used for crop production, with minimal effort placed on natural settings (Quinn et al. (2013)). To better characterize the condition of invasive and noxious species in natural areas, BLM staff co-developed definitive lists of status of species regarding their Noxious or Invasive status in 2019.

To develop a list of invasive plant species for the study area 'IRanks', a semi-quantitative expert based assessment of introduced species, were extracted from the C-Values prepared by the Colorado Natural Heritage Program (Section X.X) (Morse et al. (2004), P. Smith et al. (2020)). This was combined with an AIM species attribute table extract from the vicinity of the study area, the latter dataset contained a handful of synonyms which included codes not present in the former.

```
## During execution of the program, a warning message was generated.  The warning
## message is stored in a data frame named 'warn_df'.  Enter the following command
## to view the warning message: warnprnt()
```

To detect whether Ecological Sites differed in their resistance to noxious weed invasion a Kruskall-Wallis test was used (Kruskal & Wallis (1952)). Kruskal-Wallis was used due to non-normal data (heavily right skewed), and a small number of replicates for each Ecological Site. The Kruskall-Wallis test offered evidence of a difference (p = 0.043), to detect which Ecological Sites differed from others a two-sided Dunn's test with Holms correction for multiple testing was used as a *post-hoc* test (Dinno (2017), Ogle et al. (2022), Holm (1979), Dunn (1964)). Once p-values were adjusted for multiple testing, as we had no *a-priori* hypothesis for which sites would be more resistant, there was no strong statistical evidence that any pairs were significantly different than any others. However, this is most certainly in part due to the very few number of plots per sites (Mdn = 5.5), and the large number of sites (total = 24), rather than an actual lack of resistance in Ecological Sites.

# Results

63 introduced, and of these 54 invasive species were detected across all `r` plots. 181 plots had invasive species on them, and 148 plots had more than one invasive species. When reducing these to species of immediate management concern `r` species were present at `r` plots (REVIEW THE LIST AND THIN IT). As expected, the species which occurred the most often were Bromus tectorum, Chenopodium album, Lactuca serriola, Tragopogon dubius, Halogeton glomeratus, Sisymbrium altissimum at 113, 54, 53, 51, 50, 43 of all plots respectively. Most of the species were present across the entirety of the field office, except for ca. a dozen species which were isolated to localities between Delta and Paonia (Figure XX). Several of these species generally occur in wetter, higher elevation, habitats than most terrestrial BLM Land and their spread to BLM is minimal; however a number of the populations are adjacent to USFS land (Figure XX).

A component of reference condition for all Ecological Sites is that invasive species are not present. By this metric the plots which would be meeting their benchmarks is quite low (181), however we feel another consideration is whether an invasive species was detected on the Line-Point Intercepts (Section XX). As reference condition benchmarks still have considerable association with pre-Columbian times ecology, and much has changed in the interim, we believe each of these plots deserves another more liberal consideration. Of the plots which had invasive species, they were detected via line-point intercept at 142 of them.

There were 35 species which were detected on LPI lines at 142 plots, and of these species `r` were of immediate management concern. The proportion of all vegetation cover which was invasive at plots varied from 0% to 100% (Mdn = 3.66, mean = 14.37). In general, the few plots with exceptionally high cover of invasive species were small parcels of BLM land adjacent to roads, and private lands, in low elevation areas near Delta (figure XX).

A caveat with detecting invasive species is that, in the study area, most of them are annuals (##/##). Given the exceptional drought conditions (SECTION XX) under which field work was conducted, it is quite likely that the estimated covers of them by plot are notably lower than are during more normal conditions (Mack & Pyke (1984), Bowers (1987)).

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