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](#ref-nesom2000non))). Seeds from introduced plant species that 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, and are readily incorporated into the existing vegetation community with little alteration are considered a naturalized species (Nesom (2000), Pysek & Richardson (2010)). A subset of these species are considered noxious or invasive if they displace considerable amounts of the native plant species, and in so doing alter the composition of species and the ecological function of a site (Davies ([2011](#ref-davies2011plant)), Evans et al. ([2001](#ref-evans2001exotic)), Pysek et al. ([2012](#ref-pyvsek2012global)), Land Management ([n.d.](#ref-noxious2023blm)), *and reviewed in* Ehrenfeld ([2010](#ref-ehrenfeld2010ecosystem)), Pysek & Richardson ([2010](#ref-pyvsek2010invasive))). That a few species can alter the properties of landscapes is at the core of the Ecological Site state and transition concepts. While all invasive plants are noxious, not all noxious plants are invasive, as a number of native species which act as invasives in disturbed settings and which prevent natural succession.

Noxious and invasive species adversely affect nearly all ecosystem services offered by natural areas, increased fire frequency and intensity, loss of reliable forage base, reduced water quality and quantity, and all have enormous economic impacts (*reviwed in* Ehrenfeld ([2010](#ref-ehrenfeld2010ecosystem)), D’Antonio & Vitousek ([1992](#ref-d1992biological)), Duncan et al. ([2004](#ref-duncan2004assessing)), Fantle-Lepczyk et al. ([2022](#ref-fantle2022economic)), Crystal-Ornelas et al. ([2021](#ref-crystal2021economic))). 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](#ref-keeley2012fire)), Ehrenfeld ([2010](#ref-ehrenfeld2010ecosystem)), Klinger & Brooks ([2017](#ref-klinger2017alternative))). 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](#ref-d1992biological)), Keeley & Brennan ([2012](#ref-keeley2012fire)), @). 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 ().

In the Western cold deserts (The Colorado Plateau, Great Basin, and Columbia Plateau) noxious annual grasses pose the greatest challenge towards maintaining ecosystems and their multiple uses (Chambers et al. ([2009](#ref-chambers2009cold))). A concern in the Uncompahgre field 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](#ref-smith2022elevational))). 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](#ref-clarke2005long)), Lopez et al. ([2022](#ref-lopez2022global))).

# 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](#ref-quinn2013navigating))). 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](#ref-quinn2013navigating))). 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, a semi-quantitative expert based assessment of introduced species, were extracted from the Colorado Natural Heritage Program (Section X.X) (Morse et al. ([2004](#ref-moore2004iranks)), P. Smith et al. ([2020](#ref-cnhp2020fqi))). 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.

Once this list was developed and underwent review, we reprocessed our data to determine both the presence and absence of these species and recalculated percent fractional cover. To determine what percent of the field office were meeting benchmark reference condition, which is the same for all Ecological Sites (lack of invasive species) if an invasive was detected on a plot it was considered to be failing to meet benchmarks. These plots then underwent categorical analysis (Dumelle et al. ([2022](#ref-dumelle2022sp))),to detect whether Ecological Sites differed in their resistance to noxious/invasive weed invasion (Kruskal & Wallis ([1952](#ref-kruskal1952use))). 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 = 0.014), 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](#ref-dinno2017dunn)), Ogle et al. ([2022](#ref-ogle2022fsa)), Holm ([1979](#ref-holm1979simple)), Dunn ([1964](#ref-dunn1964multiple))). 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), and the large number of sites (total = 25), rather than an actual lack of resistance in Ecological Sites.

# Results

The monitoring design detected 74 introduced species, and of these 63 invasive species were detected across all 275 plots, 227 plots had invasive species present, and 181 plots had more than one invasive species. As expected, the species which occurred the most often were Bromus tectorum (cheatgrass) n=139, Halogeton glomeratus n=64, Chenopodium album (lambs quarter) n=61, Lactuca serriola (prickly lettuce) n=55, Tragopogon dubius (yellow salsify) n=53, and Sisymbrium altissimum (tumble mustard) n=48of 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 is 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 (227), 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 167 of them.

There were 44 species which were detected on LPI lines at 167 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 = 2.69, mean = 12.53). In general, the few plots with exceptionally high cover of invasive species were commonly 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 cover of them by plot are notably lower than can be expected during more normal conditions (Mack & Pyke ([1984](#ref-mack1984demography)), Bowers ([1987](#ref-bowers1987precipitation))). While invasive presence at plots is unlikely to change, their abundance is likely underestimated in more normal conditions (cite). We developed an ‘Invasibility index’ based on the relationship between the precent composition of invasive species relative to the precent composition of native species as the relationship is highly correlated (Figure 1). We suspect that this index is more indicative of the status of a plot in a year with more normal precipitation, as can be seen in Figure 1, the data from the sampling period generally has a large cluster of invasive cover in the lower left of the plot from (0 - 0.25 on the index axis, beneath the line), which is less representative of the potential for invasive cover to expand rapidly under normal conditions.

A handful of the invasive species detected (Whitetops (*Cardaria chalepensis*, *Cardaria draba*, alternatively *Lepidum draba*), Canada thistle (*Cirsium arvense*), field bindweed (*Convolvulus arvensis*), Timothy (*Phleum pratense*)), especially in the Northern Portion of the field office are generally associated with slightly more mesic conditions than occur at most BLM land, especially adjacent to irrigated pastures. Unless these populations are entrenched near streams, their spread is likely curtailed by the general aridity of BLM land, but their successful extirpation, in the face of continual re-colonization from adjacent pasture lands, or if they have invaded wetlands, is unlikely. Baby’s Breath (*Gypsophila elegans*) may have been introduced for roadside plantings, and is worth eradication efforts (Pringle ([1993+](#ref-pringle1993fna))). Houndstongue *Cynoglossum officinale* is generally limited to higher elevation forested areas, and in the absence of forest fire it’s spread may be slow on the portions of BLM land which it inhabits. A couple of these (Prairie Pepperweed (*Lepidium densiflorum*), prostrate knotweed (*Polygonum aviculare*)) are generally associated with heavily compacted soils, and tend to not spread aggressively outside of these areas.

A wide range of invasive species were present throughout the field office in a variety of habitats, and at varying abundances (Figure XX). All four areas of analysis within the field office, the ACEC’s - WSA’s, and the Dominguez-Escalente and Gunnison Gorge National Monuments failed to meet management objectives for being in reference condition (80% of the first three, and 70% of the remaining land) (Figure XX, panel 1). In fact none of the confidence intervals even approached the estimates required to be considered successful, the closest upper bound of a confidence interval was 1% associated with an estimate of 100% and it’s variability largely attributable to a small sample size of …

They further all failed objectives if invasive species presences were reduced to only occurrences on LPI positions (Figure XX, panel 2).

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