



# Invasive Exotic Plant Monitoring at Colorado National Monument

*2024 Field Season*



Yellow salsify (*Tragopogon dubius*) grows along a roadside in Colorado National Monument.

NPS / AMY WASHUTA

# **Invasive Exotic Plant Monitoring at Colorado National Monument: 2024 Field Season**

Science Report NPS/SR—2025/342

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Please cite this publication as:

Perkins, D. W. 2025. Invasive Exotic Plant Monitoring at Colorado National Monument: 2024 Field Season. Science Report NPS/SR—2025/342. National Park Service, Fort Collins, Colorado.  
<https://doi.org/10.36967/2314972>

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## Abstract

Invasive exotic plant (IEP) species are among the biggest threats to natural ecosystem integrity and biodiversity, and their control is a high priority for the National Park Service. The Northern Colorado Plateau Network (NCPN) selected early detection of IEPs as one of the 11 long-term monitoring protocols. This report represents work completed during the 2024 field season at Colorado National Monument (NM). From June 5 to 12, 2024, we recorded 955 patches of 14 different priority IEP species along 113.8 km (70.7 miles) of monitoring routes. Yellow sweet clover (*Melilotus officinalis*), yellow salsify (*Tragopogon dubius*), and ripgut brome (*Anisantha diandra*) were the most widespread species. Priority IEPs were found in highest numbers along the Ute Canyon (26.19 patches/km), East Glade Park Road (21.94 patches/km), Hydro 95 (21.16 patches/km), Monument Canyon (17.83 patches/km), Red Canyon (15.70 patches/km), and No Thoroughfare Canyon (14.42 patches/km) routes. Cheatgrass (*Anisantha tectorum*) was the most widespread species present in more than 80% of transects across all routes. Wedding Canyon, Fenceline, Ute Canyon, and Columbus/Red Canyon had the highest percentage cover. Field bindweed (*Convolvulus arvensis*), Russian olive (*Elaeagnus angustifolia*), yellow sweet clover, woolly mullein (*Verbascum thapsus*), and yellow salsify in most areas, and Russian olive in Red Canyon all showed large increases in the number of patches per kilometer compared to the last sample period. Many infestations per kilometer of yellow sweet clover, woolly mullein, and yellow salsify were the highest recorded from 2009 to 2024. Tamarisk was not found in Colorado NM in 2024, which represented a decrease from the last sampling periods. Jointed goatgrass (*Cylindropyrum cylindricum*) also declined from 2021 in Fruita, No Thoroughfare, and Wedding Canyons. Russian knapweed (*Acroptilon repens*) and musk thistle (*Carduus nutans*) were detected in 2024 for the first time during our monitoring.

## Acknowledgments

A. Washuta, P. Miller, B. Gottung, C. Kolb, and B. Hyde conducted field work. A. Wight was extremely helpful in generating routes, quadrats, and other GIS information. J. Resnik and B. Gottung assisted with reviewing the park priority invasive plant list, arranging site logistics, and sharing data on control efforts. C. Livensperger improved this report with her thoughtful review. Data management was provided by H. Thomas, T. Nash, and J. Brehm. M. Schrade assisted with logistical and administrative details.

# 1 Introduction

Invasive exotic species fragment native ecosystems, displace native plants and animals, and alter ecosystem function. Invasive species are among the top threats to biodiversity (Maxwell et al. 2016) and represent one of the most serious threats to natural ecosystem integrity (NRC 2002). However, biological invasions are occurring at accelerated rates in nearly every major ecosystem (Mooney and Hobbs 2000). Exotic plants negatively affect park resources and visitor enjoyment by altering landscapes and fire regimes, reducing native plant communities and animal habitat, and increasing trail maintenance needs. Recognizing these challenges, the Northern Colorado Plateau Network (NCPN) parks identified invasive exotic plants (IEPs) as a high-priority Vital Sign for long-term monitoring (O'Dell et al. 2005).

IEPs are a subset of exotic plants “whose introduction does or is likely to cause economic or environmental harm or harm to human health” (Executive Order 13112). With the aim of facilitating strategic control approaches, NCPN IEP monitoring detects early invasions, identifies existing invasions, and tracks, to the extent possible, changes in the abundance and distribution of priority IEPs in parks along key invasive pathways.

Invasive exotic plants can spread into national parks via multiple types of pathways. Predictable IEP pathways include roads, trails, and riparian corridors. Long-distance dispersal through cargo containers and air freight is an example of sudden pathways. Anthropogenic pathways include horticultural escapes and seeds transported on shoes and in restoration seed mixes. For the National Park Service, the consequences of these plant invasions present a significant challenge to the bureau’s ability to maintain natural resources “unimpaired for the enjoyment of future generations” (NPS 1916).

Because regular, comprehensive monitoring of the distribution and abundance of all exotic plant species within NCPN units is beyond the fiscal capabilities of the network and parks, the NCPN focuses on the most likely areas where a broad range of invasive exotic plants may occur: riparian corridors, reservoir shorelines, roads, trails, areas of high visitor impact (e.g., campgrounds), and park boundaries. This approach is cost-effective for finding many new invasions in areas where they are most likely to occur, but it may miss exotic plants dispersed to the interior areas of large parks by wind, animals, or both.

Specific objectives of NCPN invasive exotic plant monitoring are:

1. To detect incipient populations and new introductions of IEPs before they become established in areas of management significance and invasion pathways, and
2. To determine status and trends of selected IEP populations of management significance.

This report summarizes IEP monitoring results from the 2024 field season at Colorado National Monument (NM).

## 2 Methods

We followed the invasive plant monitoring protocol developed by the NCPN (Perkins et al. 2016). The protocol emphasizes the rapid collection of IEP location and abundance data to maximize the area searched, thus increasing our chances of finding a higher percentage of both new invasions and established IEPs. By focusing on roads, trails, and waterways, which are major vectors for invasive plants, we capture the greatest amount of information (i.e., benefit) with the least amount of time and effort (i.e., cost).

After park and NCPN staff reviewed the list of priority invasive plants (see Section 2.1), we established a series of co-located monitoring routes and quadrats along all roads, shorelines, major drainages, and trails in the park. The quadrats, which are sampled quantitatively, are used to make inferences about the percent cover of IEPs located along the park's invasive pathways (i.e., the monitoring routes) and allow us to estimate trends in IEP percent cover over time. The monitoring routes, which are not quantitatively sampled, are used to increase the spatial coverage of mapping performed, maximizing our opportunities for detecting IEPs in the park.

### 2.1 Developing a Park Priority Invasive Exotic Plant List

Prior to beginning monitoring in 2024, staff from the NCPN and Colorado NM reviewed the park's list of priority IEPs (Table 1). The original list of target IEPs was developed by reviewing past park literature and state and county weed lists, as well as consulting with park staff and county weed managers. The priority IEP list includes existing IEPs and potential IEPs of high management concern. Because these methods were designed to be rapid, field crews were trained to develop a focused search image for the priority IEPs, rather than looking for every possible invasive plant species. Eradicating these priority species, or containing them within a park, is still thought to be possible.

**Table 1.** Priority invasive plant list, Colorado NM, 2009–2024.

| Scientific Name                       | Common Name      | Years on Priority List |
|---------------------------------------|------------------|------------------------|
| <i>Acosta diffusa</i>                 | diffuse knapweed | 2009–2024              |
| <i>Acosta maculosa</i>                | spotted knapweed | 2009–2024              |
| <i>Acroptilon repens</i>              | Russian knapweed | 2009–2024              |
| <i>Anisantha diandra</i> <sup>A</sup> | ripgut brome     | 2019–2024              |

<sup>A</sup> Added in 2019.

<sup>B</sup> *Cardaria draba* was specified until 2017, when it was converted to *Cardaria* sp. *C. latifolia* continues to be identified as a separate species.

<sup>C</sup> *C. latifolia* is listed separately from *Cardaria* sp. because it is easy to differentiate from other *Cardaria* species. Also, *C. latifolia* can require different control strategies than other *Cardaria* species.

<sup>D</sup> Added in 2015.

<sup>E</sup> Added in 2024.

<sup>F</sup> Added in 2011.

**Table 1 (continued).** Priority invasive plant list, Colorado NM, 2009–2024.

| Scientific Name                            | Common Name           | Years on Priority List |
|--------------------------------------------|-----------------------|------------------------|
| <i>Arctium minus</i>                       | burdock               | 2009–2024              |
| <i>Breia arvensis</i>                      | Canada thistle        | 2009–2024              |
| <i>Cardaria</i> sp. <sup>B</sup>           | hoary cress           | 2009–2024              |
| <i>Cardaria latifolia</i> <sup>C</sup>     | perennial pepperweed  | 2009–2024              |
| <i>Carduus acanthoides</i>                 | plumeless thistle     | 2009–2024              |
| <i>Carduus nutans</i>                      | musk thistle          | 2009–2024              |
| <i>Chorispora tenella</i> <sup>D</sup>     | blue mustard          | 2015–2024              |
| <i>Cirsium vulgare</i>                     | bull thistle          | 2009–2024              |
| <i>Convolvulus arvensis</i>                | field bindweed        | 2009–2024              |
| <i>Cylindropyrum cylindricum</i>           | jointed goatgrass     | 2009–2024              |
| <i>Cynoglossum officinale</i> <sup>D</sup> | common hound's-tongue | 2015–2024              |
| <i>Descurainia sophia</i> <sup>D</sup>     | flixweed              | 2015–2024              |
| <i>Elaeagnus angustifolia</i>              | Russian olive         | 2009–2024              |
| <i>Halogeton glomeratus</i> <sup>E</sup>   | halogeton             | 2024                   |
| <i>Isatis tinctoria</i>                    | Dyer's woad           | 2009–2024              |
| <i>Leucantha solstitialis</i>              | yellow starthistle    | 2009–2024              |
| <i>Linaria vulgaris</i>                    | yellow toadflax       | 2009–2024              |
| <i>Lythrum salicaria</i>                   | purple loosestrife    | 2009–2024              |
| <i>Marrubium vulgare</i> <sup>E</sup>      | common horehound      | 2024                   |
| <i>Melilotus officinalis</i> <sup>F</sup>  | yellow sweet clover   | 2009, 2013–2024        |
| <i>Onopordum acanthium</i>                 | Scotch thistle        | 2009–2024              |
| <i>Tamarix</i> spp.                        | tamarisk              | 2009–2024              |
| <i>Tithymalus esula</i>                    | leafy spurge          | 2009–2024              |
| <i>Tragopogon dubius</i> <sup>D</sup>      | yellow salsify        | 2015–2024              |
| <i>Tribulus terrestris</i>                 | puncturevine          | 2009–2024              |
| <i>Ulmus pumila</i>                        | Siberian elm          | 2009–2024              |
| <i>Verbascum thapsus</i>                   | woolly mullein        | 2009–2024              |

<sup>A</sup> Added in 2019.

<sup>B</sup> *Cardaria draba* was specified until 2017, when it was converted to *Cardaria* sp. *C. latifolia* continues to be identified as a separate species.

<sup>C</sup> *C. latifolia* is listed separately from *Cardaria* sp. because it is easy to differentiate from other *Cardaria* species. Also, *C. latifolia* can require different control strategies than other *Cardaria* species.

<sup>D</sup> Added in 2015.

<sup>E</sup> Added in 2024.

<sup>F</sup> Added in 2011.

Prior to the start of monitoring in 2024, NCPN and park staff reviewed the list of priority IEPs (Table 1). Park staff requested that common horehound (*Marrubium vulgare*) and halogeton (*Halogeton glomeratus*) be added to the 2024 target list.

Cheatgrass (*Anisantha tectorum*) has been recorded in transect quadrats since 2011. Tumble mustard (*Sisymbrium altissimum*), Russian thistle (*Salsola* sp.), and redstem filaree (*Erodium cicutarium*) were recorded in transect quadrats starting in 2017.

## **2.2 Monitoring Routes**

While observers strive to observe and map all priority IEP patches along monitoring routes, some priority IEP species, especially those with low numbers and small size, will inevitably be overlooked. To account for these non-detections, the NCPN has developed a minimum detection target size (MDTS), effective detection distance (EDD), and effective detection swath width (EDSW) that are based on the observability of the least-visible priority IEP species. Therefore, these areas and distances should be considered conservative estimates of an observer's ability to detect IEP patches, as most (and potentially, all) IEP patches mapped during monitoring are made up of more easily visible species. As a result, many mapped patches of priority IEP species are observed partially or completely beyond these values.

### **2.2.1 Minimum Detection Target Size**

The minimum detection target size (MDTS) represents the patch size large enough to detect with a high level of confidence (typically at least 90% of the total number of patches of that size and larger in the monitoring area) under actual field conditions, but small enough that any missed patches smaller than the MDTS could still feasibly be eradicated if not found until the next scheduled monitoring visit. The NCPN has established an MDTS of 40 m<sup>2</sup> (0.01 acres, or approximately 20 × 20 ft) for all priority IEPs. Use of the MDTS is necessary because field technicians are not expected to find every single plant of every priority IEP species during route surveys. Although searching for single mature plants of some priority IEP species, such as tamarisk (*Tamarix* sp.), is possible due to their large size, single plants of other priority IEP species, such as field bindweed (*Convolvulus arvensis*), are nearly impossible to detect in most field conditions unless the observer is very near the patch.

### **2.2.2 Effective Detection Distance**

The effective detection distance (EDD) is the maximum distance from which a searcher can consistently detect (i.e., see and recognize) the MDTS of the least-visible priority IEP species with at least 90% detection efficiency (Figure 1). Crew members are trained to quantify EDD by walking away from the least-visible priority IEP species (or, if this species is not present, plants of similar stature) from a MDTS (i.e., 40 m<sup>2</sup>) and determining the maximum distance from which they could consistently see and recognize this patch with complete confidence.

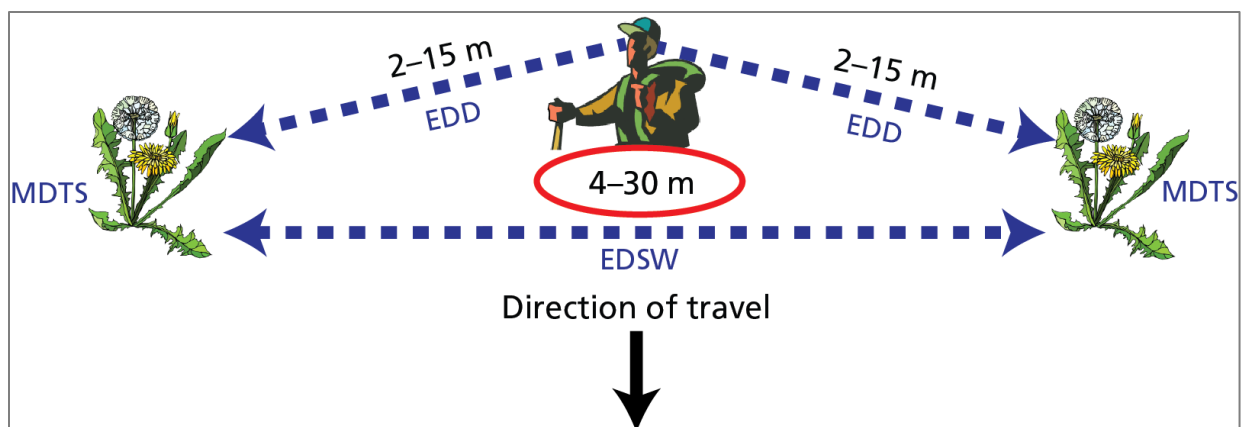


**Figure 1.** The maximum Effective Detection Distance (EDD) at Colorado NM ranged from 2–15 meters in 2024, making the Effective Detection Swath Width (EDSW) 4–30 meters.

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The size of the EDD is quantified in the field by crew members at the start of each monitoring route and adjusted as necessary, depending on surrounding vegetation and terrain. In 2024, the EDD for Colorado NM was between 2 and 15 m.

### **2.2.3 Effective Detection Swath Width**

Effective detection swath width (EDSW) is defined as the maximum width of a linear search swath (band transect) in which a walking observer is confident of visually detecting 90% of all priority species meeting the MDTS (Figure 1). The effective detection swath width (EDSW) is equal to two times the EDD, because the surveyor can effectively detect priority IEPs for one EDD on either side of the search route. The EDSW ranged from 4 to 30 meters at Colorado NM in 2024.

### **2.2.4 Patch Separation Resolution**

We define patch separation resolution (PSR) as the minimum distance between plants that must be considered members of separate infestations or patches. Individuals or clusters of a priority species separated by the PSR distance or more are recorded as separate patches. We consider plants separated by less than the PSR to be a single patch. The PSR is set at 50 m based on the assumption that most plants or groups of plants separated by less than 50 m are typically considered one patch during planning and implementation of weed control operations. If a patch is continuous for more than 50 m, cover estimates are made every 50 m to aid in developing an effective management strategy for the entire patch.

### **2.2.5 Data Collection Methods**

Observers walked down the center of the route, searching for priority IEPs by visually scanning side-to-side all the land within the EDSW. For East Glade Park Road, we walked one meter out from one side of the road and then returned to the starting point by walking back one meter from the road on the other side. If the terrain was uneven or steep and the observers had to glance frequently at the ground to ensure safe foot placement, searchers stopped approximately every 8–60 meters (the length of one EDSW) and visually scanned the area in all directions. As monitoring routes were traversed,

locations of all priority species were documented using GPS units with at least 5 m of accuracy. Only species designated as priority were consistently recorded on monitoring routes. Survey crew members were allowed to record additional IEP species if they were noteworthy.

When a priority IEP was discovered, we recorded the following information: (1) monitoring route, (2) sequential number of the invasion per monitoring route, (3) patch size class (see below), (4) whether the plant was pulled, and (5) cover class (see below). If several species were present with similar distributions at a single point, then we recorded a point for each individual species and assigned it its own sequential identification number. Invasions more than 50 m apart were considered separate patches and recorded with a separate point.

Patch size class was estimated as follows:

1. 1–3 plants (used for isolated single plants or very small patches of  $\leq 2 \times 2$  m),
2. Four plants–40 m<sup>2</sup> (48 yd<sup>2</sup>),
3. 40–400 m<sup>2</sup> (48–478 yd<sup>2</sup>),
4. 400–1,000 m<sup>2</sup> (0.1–0.25 acre), and
5. 1,000–2,000 m<sup>2</sup> (0.25–0.5 acre).

We recorded cover class by estimating the amount, or percentage, of ground covered by the vertical projection of plant matter in the patch as visualized from a bird's-eye view of the vegetation (Elzinga et al. 1998). This estimate included both the living and dead standing material of the vegetation from a single plant species. Percent cover of a patch was recorded using the following classes:

1. Trace (<1%)
2. Low (1–5%)
3. Moderate (6–25%)
4. High (26–50%)
5. Majority (51–100%)

We recorded the following ancillary information with every patch: descriptive notes (e.g., hillside, distance to road, wetland, stream); the growth stage of exotic trees (i.e., seedling, sapling, mature tree); evidence of prior treatment; and evidence of disturbances (e.g., recent fire, flood, small mammal disturbance).

### **2.3 Monitoring Transects and Quadrats**

The ability to map priority IEPs along routes is inherently subjective because of differences in observer experience and attention to detail. Furthermore, the broad cover classes used in mapping are insufficient to accurately represent the percentage cover of an IEP along monitoring routes. To improve consistency in detecting and quantifying IEPs among observers, we supplemented IEP mapping with additional observations along transects.

Transects were established every 500 m along monitoring routes. Transects extended perpendicularly from the edge of a route being walked and on alternating sides of routes consisting of narrow riparian areas, small roads, or trails. Along each transect, we established up to three 1 m<sup>2</sup> sampling frames (i.e., quadrats) to quantify vegetation cover and soil surface features. Quadrats were centered at 0.5, 5, and 10 m along the right side of the transect line as the technician walked from the monitoring route. In some cases, quadrats could not be placed at 5 and 10 m due to safety concerns. When necessary, observers leveled the sampling frame by propping up quadrat corners.

Plants recorded as present in quadrats include both plants rooted within quadrats and plants rooted outside of, but leaning over, the quadrat frame. For each quadrat, we recorded percent cover of each IEP using the following classes: <1, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100%. We also recorded percent cover of dominant soil surface features (i.e., dead wood, dung, fungus, lichen, litter/duff, live root/bole, mineral soil/sediment, moss, biological soil crust, road, rock, standing water/flooded, stream, or trash/junk) using the same classes.

## **2.4 Analyses**

We calculated the mean number of patches per kilometer for monitoring routes. Percent cover estimates for individual or grouped monitoring routes were generated from monitoring transect data. We calculated the mean and standard error of percent cover by species for monitoring quadrats. Because of differences in observers' knowledge and potential inconsistencies in identifying species not listed on the priority IEP list, only priority species were used when comparing results from year to year, as shown in Table 1.

## 3 Results

### 3.1 Priority Invasive Exotic Plant List

In 2024, field crews searched monitoring routes for 31 species identified as high priority at Colorado NM (see Table 1). Observers were trained to recognize priority species but given the freedom to map additional species. Therefore, presence and absence data for priority species are reliable for the areas searched, but presence and absence data for other species may be less reliable. We detected 14 priority IEP and eight non-priority IEP species along 113.8 km (70.7 miles) of monitoring routes and 236 transects in 2024 (Table 2, see Figure 2).

**Table 2.** Invasive exotic plants detected at Colorado National Monument, June 5–12, 2024.

| Scientific Name                  | Common Name         | Method Detected   | Park Priority |
|----------------------------------|---------------------|-------------------|---------------|
| <i>Acrotilon repens</i>          | Russian knapweed    | Routes            | Yes           |
| <i>Anisantha diandra</i>         | ripgut brome        | Routes, Transects | Yes           |
| <i>Anisantha tectorum</i>        | Cheatgrass          | Transects         | No            |
| <i>Asparagus officinalis</i>     | asparagus           | Routes            | No            |
| <i>Breea arvensis</i>            | Canada thistle      | Routes            | Yes           |
| <i>Bromus japonicus</i>          | Japanese brome      | Transects         | No            |
| <i>Carduus nutans</i>            | musk thistle        | Routes            | Yes           |
| <i>Chorispora tenella</i>        | blue mustard        | Routes, Transects | Yes           |
| <i>Cirsium vulgare</i>           | bull thistle        | Routes            | Yes           |
| <i>Convolvulus arvensis</i>      | field bindweed      | Routes            | Yes           |
| <i>Cylindropyrum cylindricum</i> | jointed goatgrass   | Routes            | Yes           |
| <i>Elaeagnus angustifolia</i>    | Russian olive       | Routes            | Yes           |
| <i>Erodium cicutarium</i>        | stork's bill        | Transects         | No            |
| <i>Halogeton glomeratus</i>      | halogeton           | Routes, Transects | Yes           |
| <i>Melilotus officinalis</i>     | yellow sweet clover | Routes, Transects | Yes           |
| <i>Populus alba</i>              | white poplar        | Routes            | No            |
| <i>Tragopogon dubius</i>         | yellow salsify      | Routes, Transects | Yes           |
| <i>Triticum aestivum</i>         | wheat               | Routes            | No            |
| <i>Salsola</i> sp.               | Russian thistle     | Transects         | No            |
| <i>Sisymbrium altissimum</i>     | tumble mustard      | Transects         | No            |
| <i>Ulmus pumila</i>              | Siberian elm        | Routes            | Yes           |
| <i>Verbascum thapsus</i>         | woolly mullein      | Routes            | Yes           |



### 3.2 Monitoring Routes

A total of 959 patches of 14 different priority species were detected along the monitoring routes (Tables 3 and 4; Figures 3 to 17; NCPN 2025a). Priority IEPs were found in highest numbers along the Ute Canyon (26.19 patches/km), East Glade Park Road (21.94 patches/km), Hydro 95 (21.16 patches/km), Monument Canyon (17.83 patches/km), Red Canyon (15.70 patches/km), and No Thoroughfare Canyon (14.42 patches/km) routes (see Table 3). Infestations were most common in riparian areas, less common along roads, and least common on trails. Hydro 11, Devil's Kitchen Trail, Liberty Cap Trail, and Monument Canyon Trail had the lowest number of IEPs per kilometer.

**Table 3.** Monitoring routes surveyed, route type, length, number of priority IEP infestations, and number of infestations/km, Colorado NM, June 5–12, 2024.

| Route                   | Type of Route | Length (m)    | # of Priority Infestations | Infestations/km |
|-------------------------|---------------|---------------|----------------------------|-----------------|
| Columbus Canyon         | Riparian      | 1,790         | 12                         | 6.71            |
| Fruita Canyon           | Riparian      | 2,214         | 8                          | 3.61            |
| Gold Star Canyon        | Riparian      | 509           | 5                          | 9.83            |
| Hydro 03                | Riparian      | 421           | 2                          | 4.75            |
| Hydro 11                | Riparian      | 1,228         | 1                          | 0.81            |
| Hydro 82                | Riparian      | 1,428         | 12                         | 8.40            |
| Hydro 95                | Riparian      | 2,788         | 59                         | 21.16           |
| Kodels Canyon           | Riparian      | 463           | 2                          | 4.32            |
| Limekiln Gulch          | Riparian      | 503           | 1                          | 1.99            |
| Lizard Canyon           | Riparian      | 1,396         | 4                          | 2.86            |
| Monument Canyon         | Riparian      | 9,365         | 167                        | 17.83           |
| No Thoroughfare Canyon  | Riparian      | 8,251         | 119                        | 14.42           |
| Red Canyon              | Riparian      | 3,886         | 61                         | 15.70           |
| Ute Canyon              | Riparian      | 7,254         | 190                        | 26.19           |
| Wedding Canyon          | Riparian      | 2,957         | 10                         | 3.38            |
| East Glade Park         | Road          | 6,747         | 148                        | 21.94           |
| Rim Rock Drive          | Road          | 11,696        | 52                         | 4.45            |
| Rim Rock Drive East     | Road          | 10,220        | 26                         | 2.54            |
| Access to Kodels Canyon | Trail         | 1,183         | 3                          | 2.54            |
| Devil's Kitchen         | Trail         | 1,227         | 1                          | 0.81            |
| Fenceline               | Trail         | 15,414        | 38                         | 2.47            |
| Liberty Cap             | Trail         | 9,920         | 14                         | 1.41            |
| Monument Canyon         | Trail         | 7,662         | 7                          | 0.91            |
| No Thoroughfare         | Trail         | 4,621         | 16                         | 3.46            |
| <b>Riparian Totals</b>  | –             | <b>45,089</b> | <b>654</b>                 | <b>14.50</b>    |
| <b>Road Totals</b>      | –             | <b>28,663</b> | <b>226</b>                 | <b>7.88</b>     |
| <b>Trail Totals</b>     | –             | <b>40,027</b> | <b>79</b>                  | <b>1.97</b>     |

**Table 4.** Species observed and infestation size class detected along all monitoring routes, Colorado NM, June 5–12, 2024.

| Species                                   | Total Infestations | No Size Class Recorded | 1 to Few Plants | Few Plants–40 m <sup>2</sup> | 40–400 m <sup>2</sup> | 400–1000 m <sup>2</sup> | >1000 m <sup>2</sup> |
|-------------------------------------------|--------------------|------------------------|-----------------|------------------------------|-----------------------|-------------------------|----------------------|
| <i>Acroptilon repens</i>                  | 3                  | 1                      | 0               | 2                            | 0                     | 0                       | 0                    |
| <i>Anisantha diandra</i>                  | 86                 | 1                      | 0               | 10                           | 73                    | 2                       | 0                    |
| <i>Asparagus officinalis</i> <sup>A</sup> | 5                  | 5                      | 0               | 0                            | 0                     | 0                       | 0                    |
| <i>Breea arvensis</i>                     | 2                  | 0                      | 0               | 1                            | 1                     | 0                       | 0                    |
| <i>Carduus nutans</i>                     | 3                  | 1                      | 0               | 0                            | 2                     | 0                       | 0                    |
| <i>Chorispota tenella</i>                 | 3                  | 1                      | 0               | 1                            | 0                     | 1                       | 0                    |
| <i>Cirsium vulgare</i>                    | 11                 | 7                      | 0               | 4                            | 0                     | 0                       | 0                    |
| <i>Convolvulus arvensis</i>               | 37                 | 5                      | 0               | 25                           | 7                     | 0                       | 0                    |
| <i>Cylindropyrum cylindricum</i>          | 8                  | 7                      | 0               | 1                            | 0                     | 0                       | 0                    |
| <i>Elaeagnus angustifolia</i>             | 25                 | 22                     | 0               | 3                            | 0                     | 0                       | 0                    |
| <i>Halogeton glomeratus</i>               | 29                 | 9                      | 0               | 8                            | 5                     | 6                       | 1                    |
| <i>Melilotus officinalis</i>              | 448                | 32                     | 0               | 73                           | 221                   | 97                      | 25                   |
| <i>Populus alba</i> <sup>A</sup>          | 1                  | 1                      | 0               | 0                            | 0                     | 0                       | 0                    |
| <i>Tragopogon dubius</i>                  | 253                | 63                     | 0               | 111                          | 71                    | 8                       | 0                    |
| <i>Triticum aestivum</i> <sup>A</sup>     | 1                  | 0                      | 0               | 1                            | 0                     | 0                       | 0                    |
| <i>Ulmus pumila</i>                       | 8                  | 7                      | 0               | 1                            | 0                     | 0                       | 0                    |
| <i>Verbascum thapsus</i>                  | 43                 | 6                      | 0               | 10                           | 25                    | 2                       | 0                    |
| Priority Species Total                    | 959                | 162                    | 0               | 250                          | 405                   | 116                     | 26                   |

<sup>A</sup> Not a priority species.

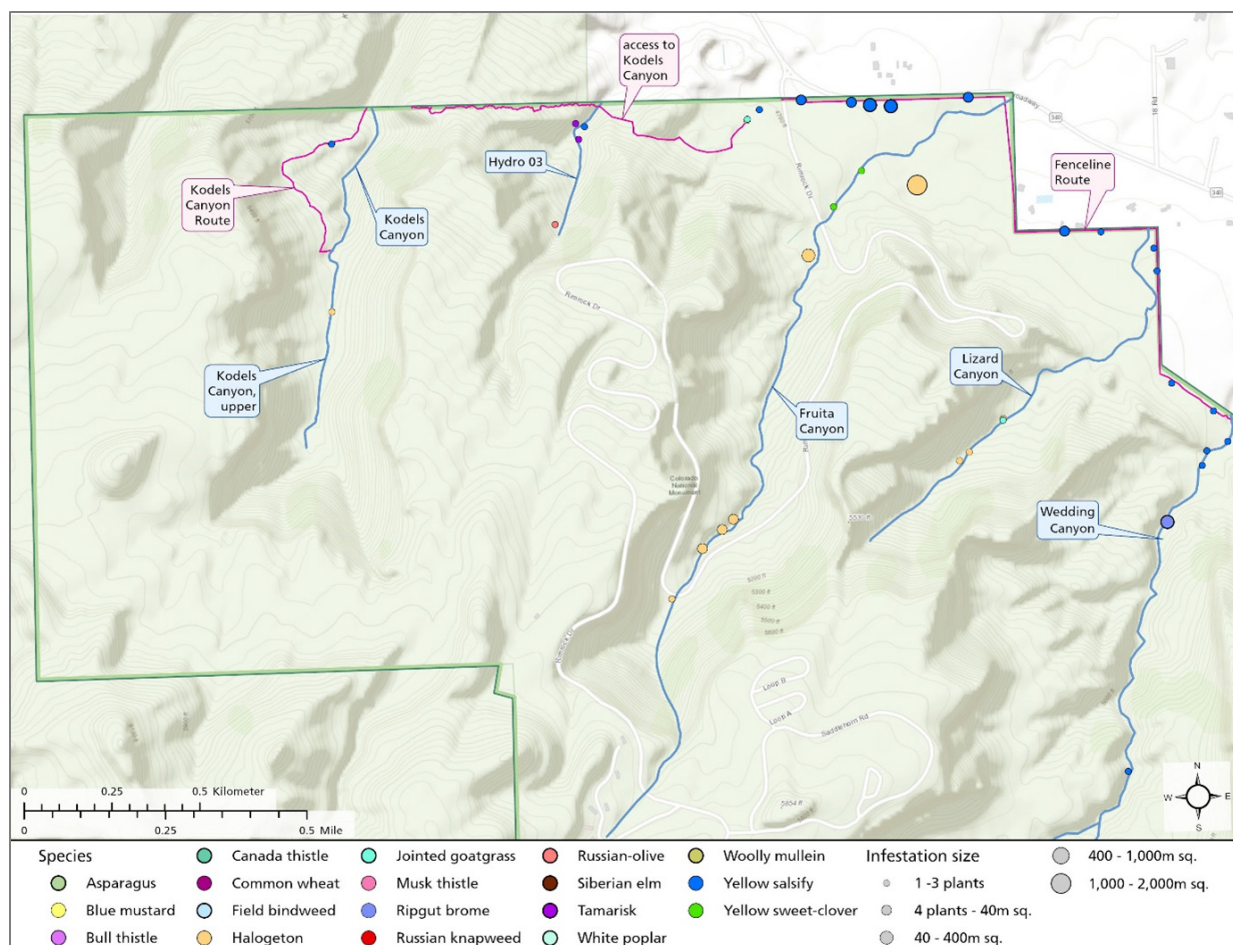


**Figure 3.** Invasive plants detected on monitoring routes in the vicinity of the Fruita Canyon, Colorado NM, June 5–12, 2024.

NPS / ANETH WIGHT

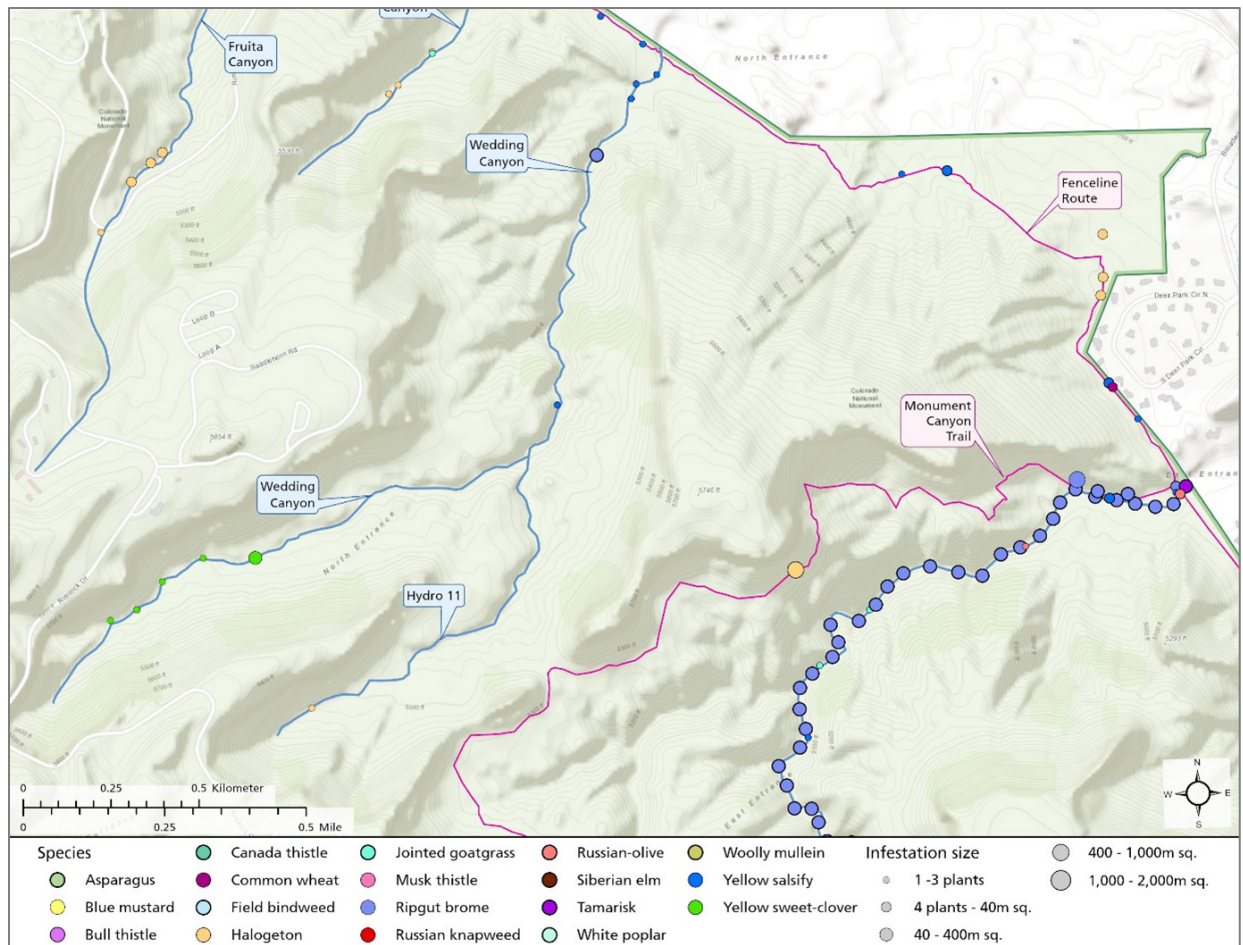


**Figure 4.** Invasive plants detected on monitoring routes in the vicinity of Wedding Canyon, Colorado NM, June 5–12, 2024.

NPS / ANETH WIGHT

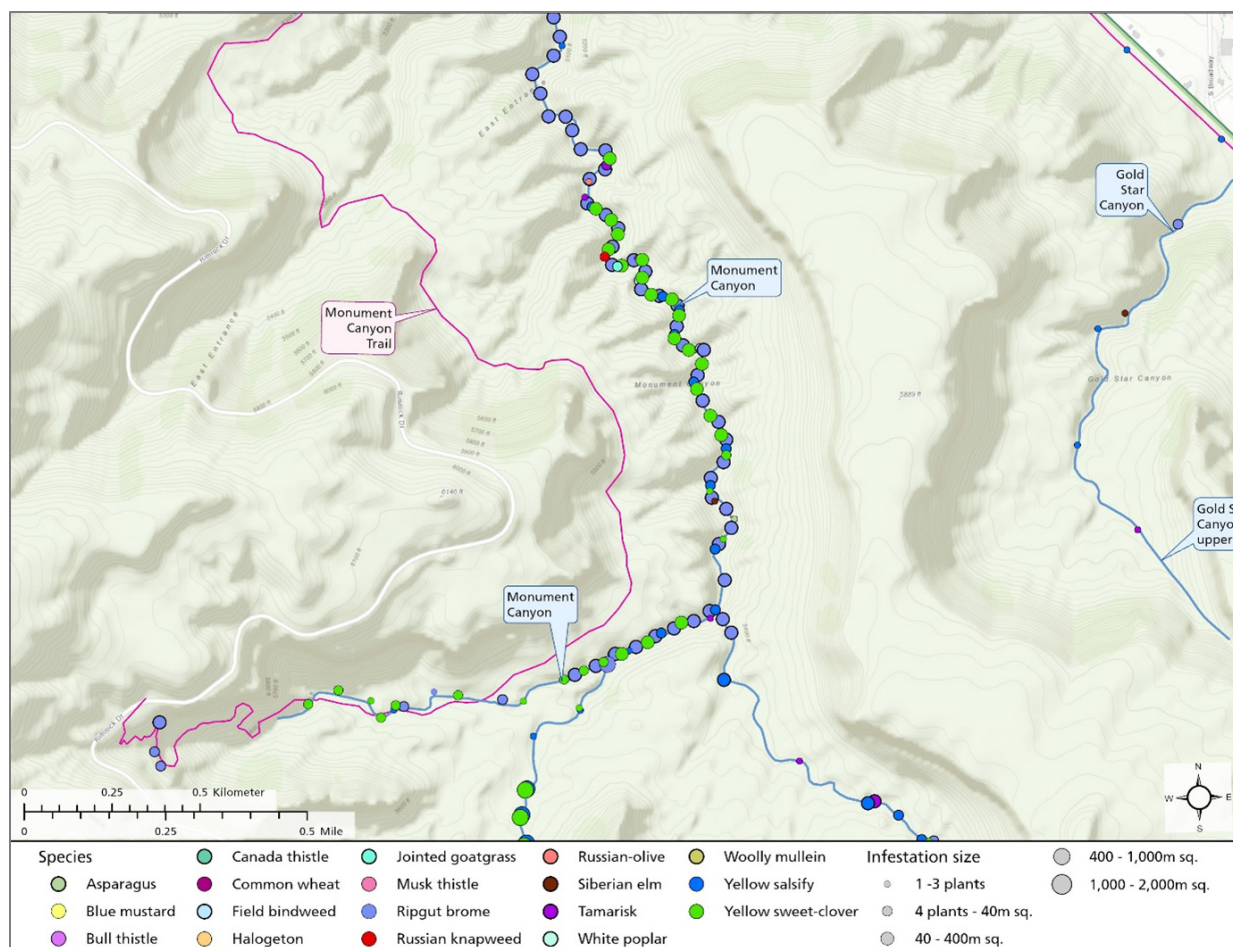


**Figure 5.** Invasive plants detected on monitoring routes along Monument Canyon, Colorado NM, June 5–12, 2024.

NPS / ANETH WIGHT

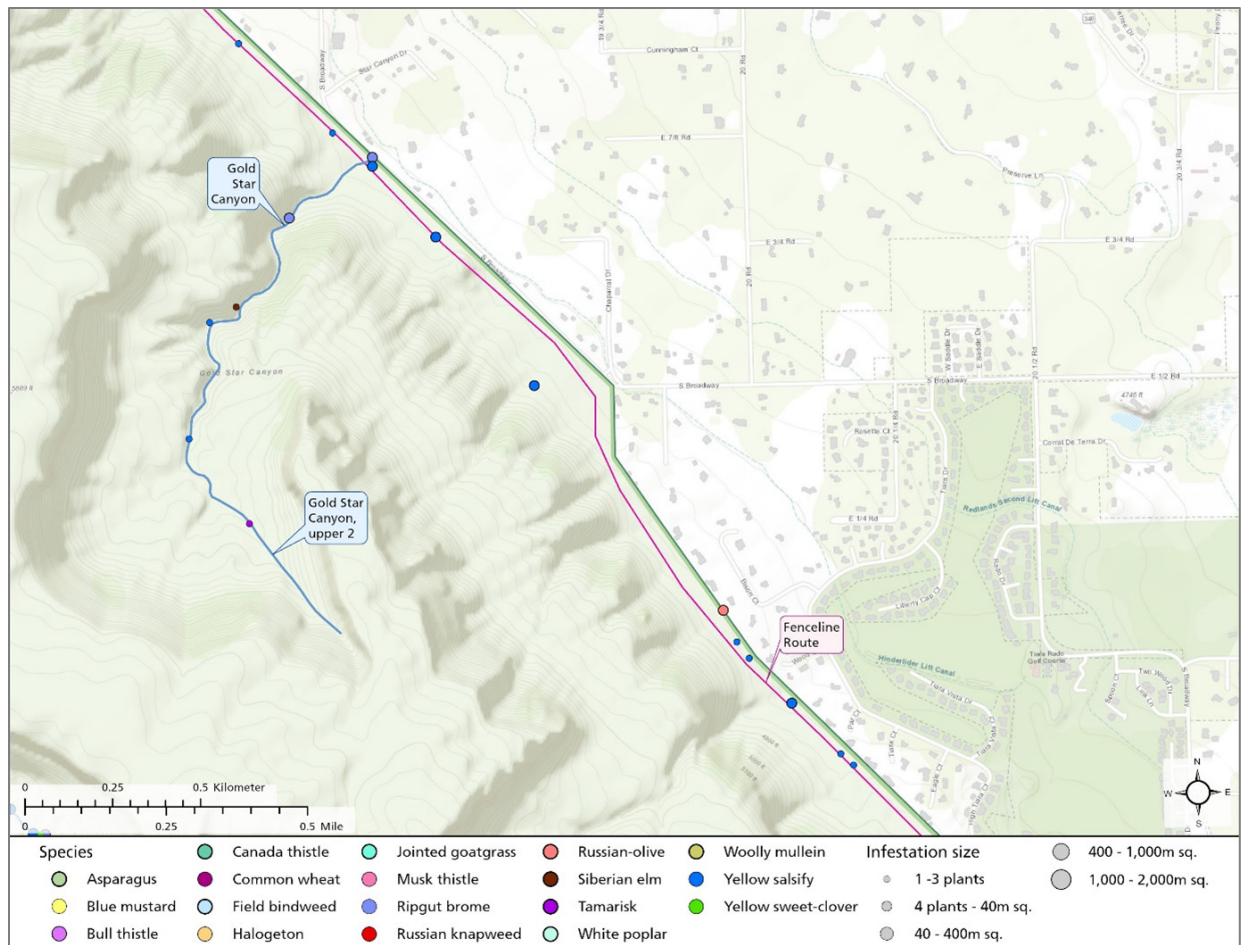


**Figure 6.** Invasive plants detected on monitoring routes around Goldstar Canyon, Colorado NM, June 5–12, 2024.

NPS / ANETH WIGHT

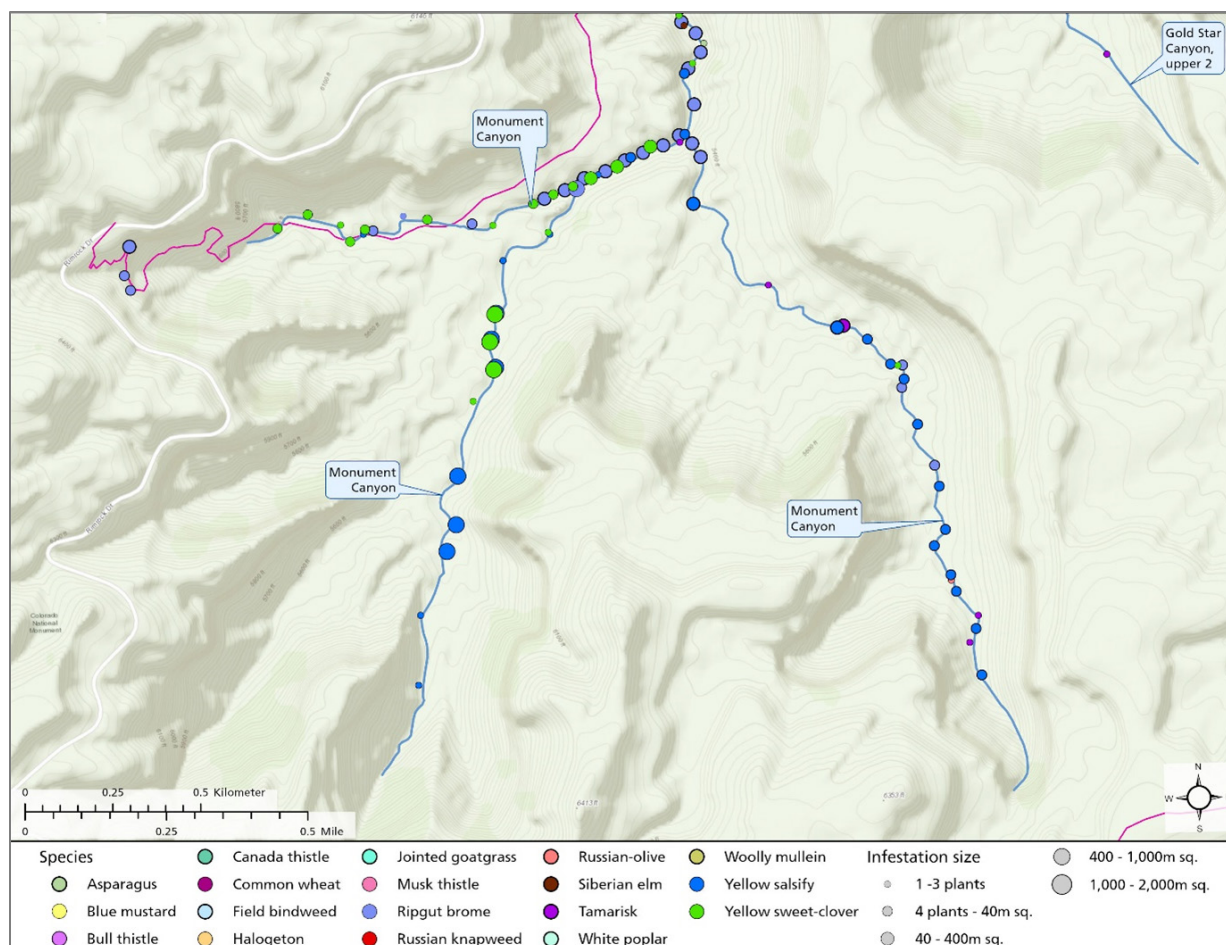


**Figure 7.** Invasive plants detected on monitoring routes in the vicinity of the southern portion of Monument Canyon, Colorado NM, June 5–12, 2024.

NPS / ANETH WIGHT

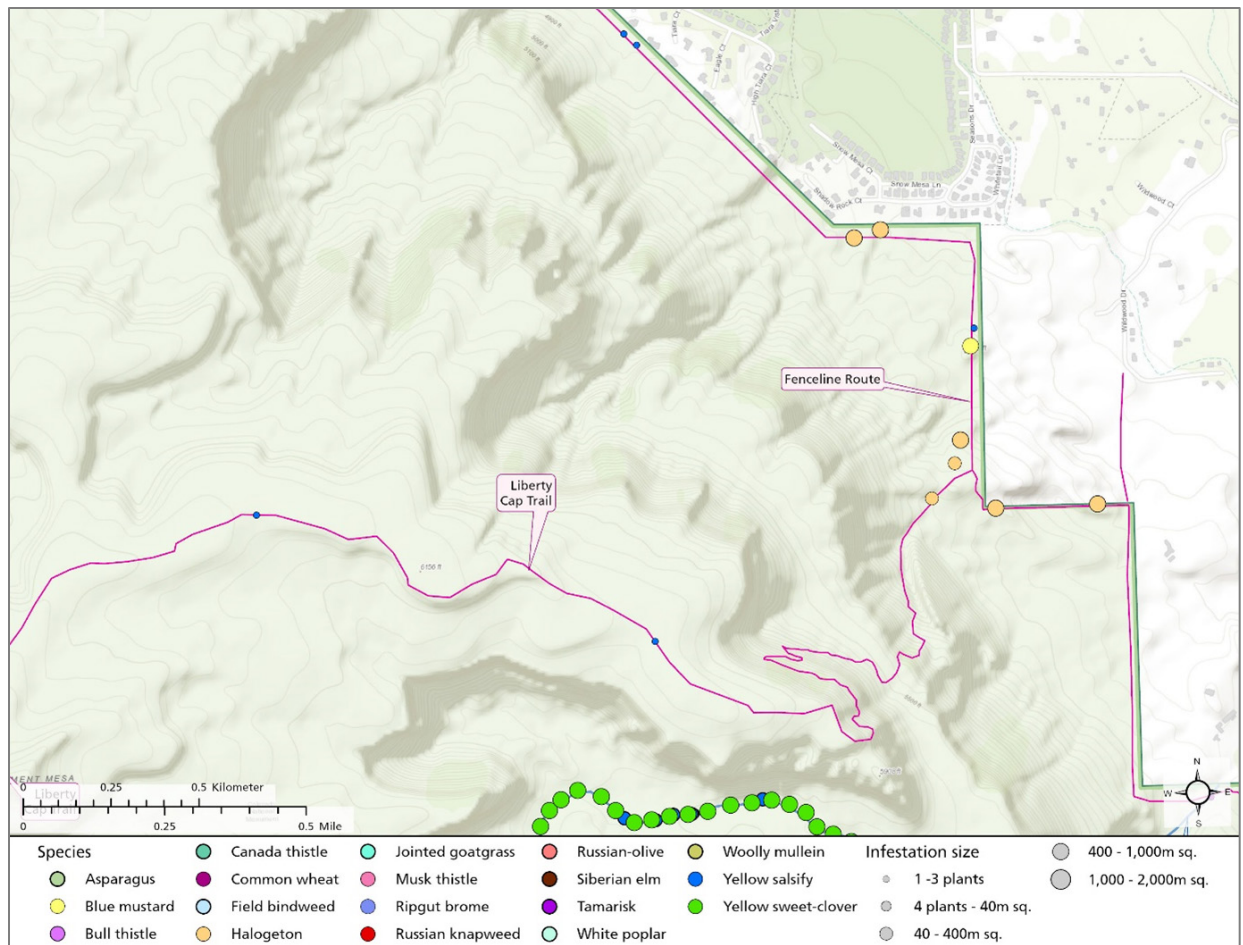


**Figure 8.** Invasive plants detected on monitoring routes in the vicinity of the Liberty Cap Trail, Colorado NM, June 5–12, 2024.

NPS / ANETH WIGHT

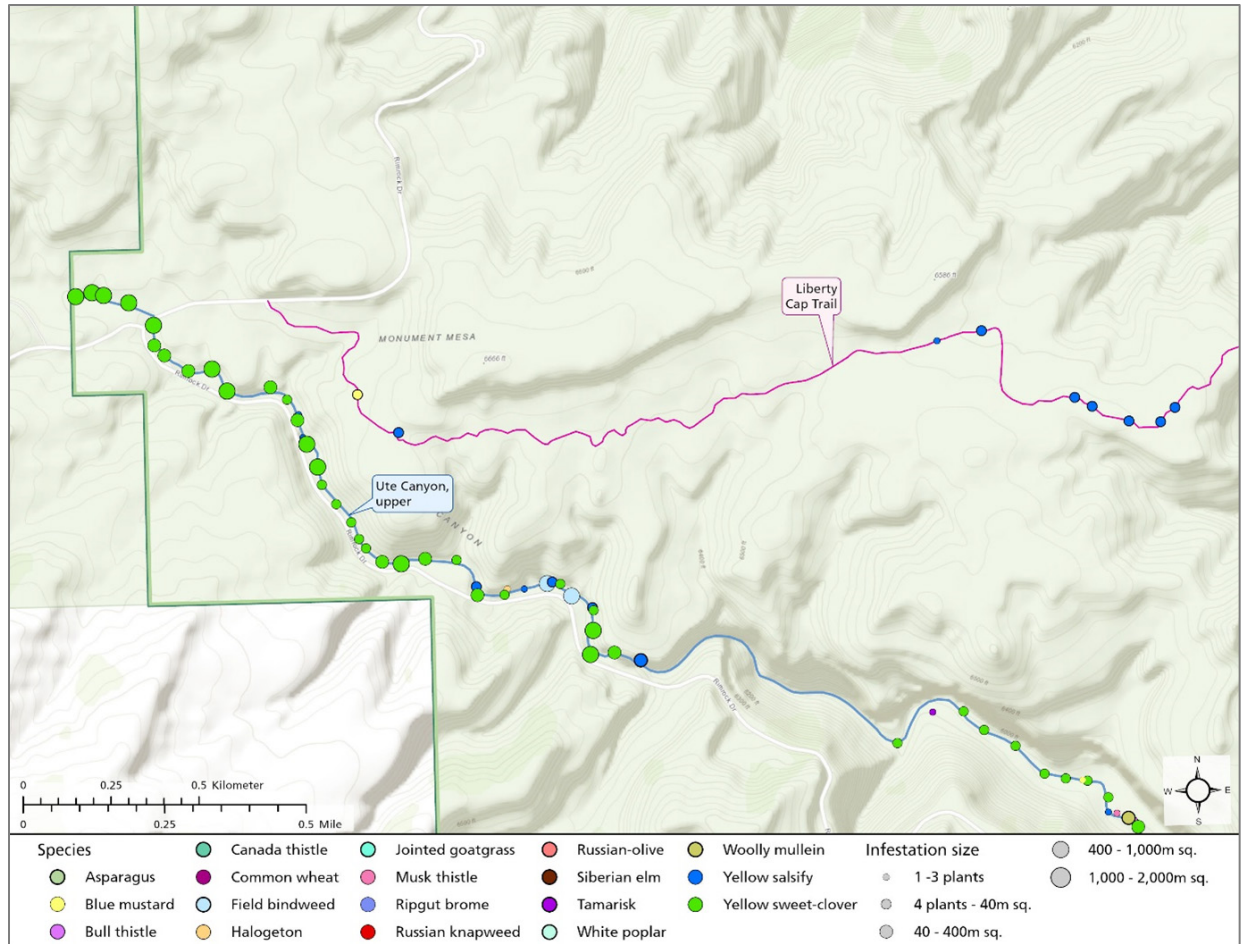


**Figure 9.** Invasive plants detected on monitoring routes in the vicinity of upper Ute Canyon, Colorado NM, June 5–12, 2024.

NPS / ANETH WIGHT

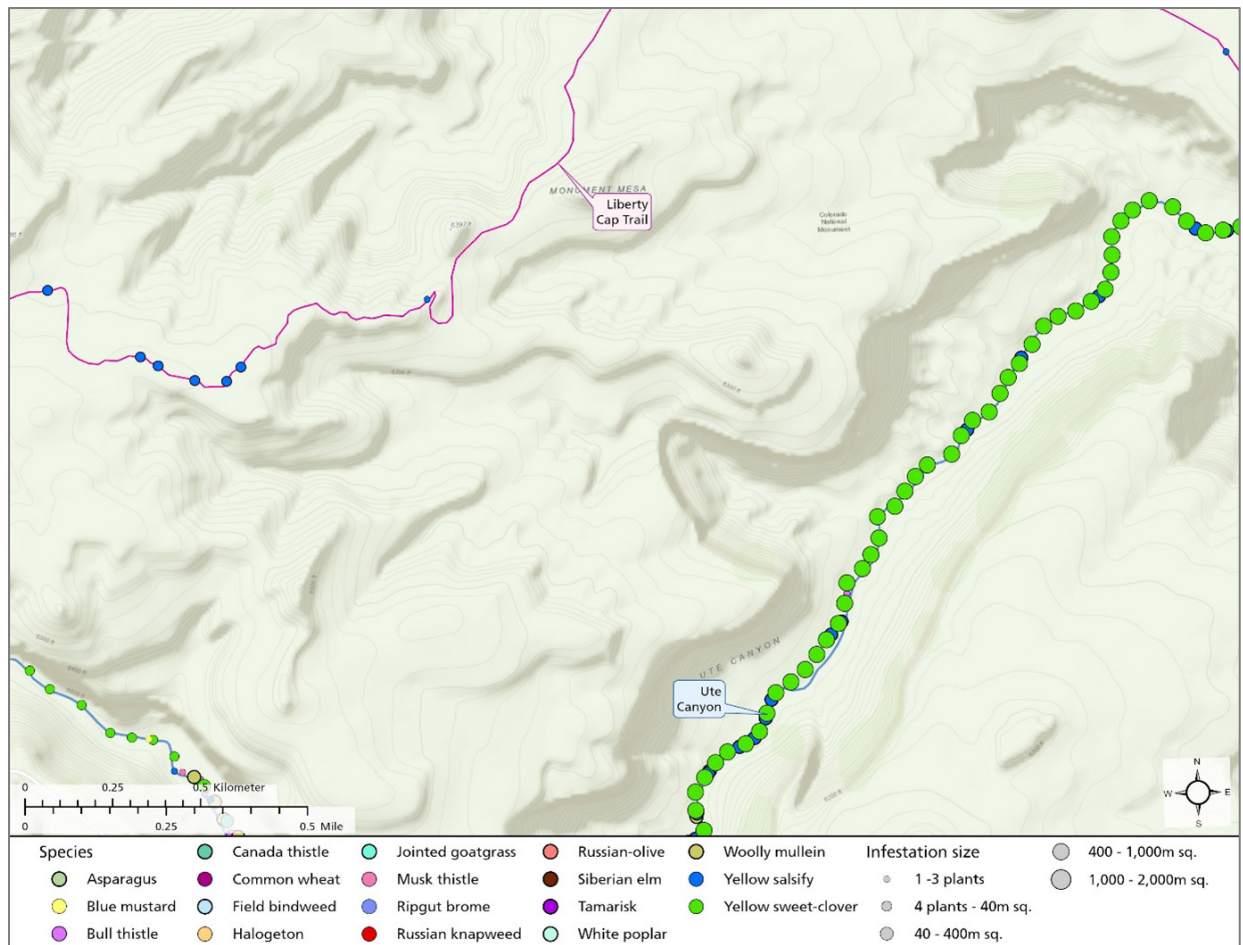


**Figure 10.** Invasive plants detected on monitoring routes in the vicinity of the western portion of Ute Canyon, Colorado NM, June 5–12, 2024.

NPS / ANETH WIGHT

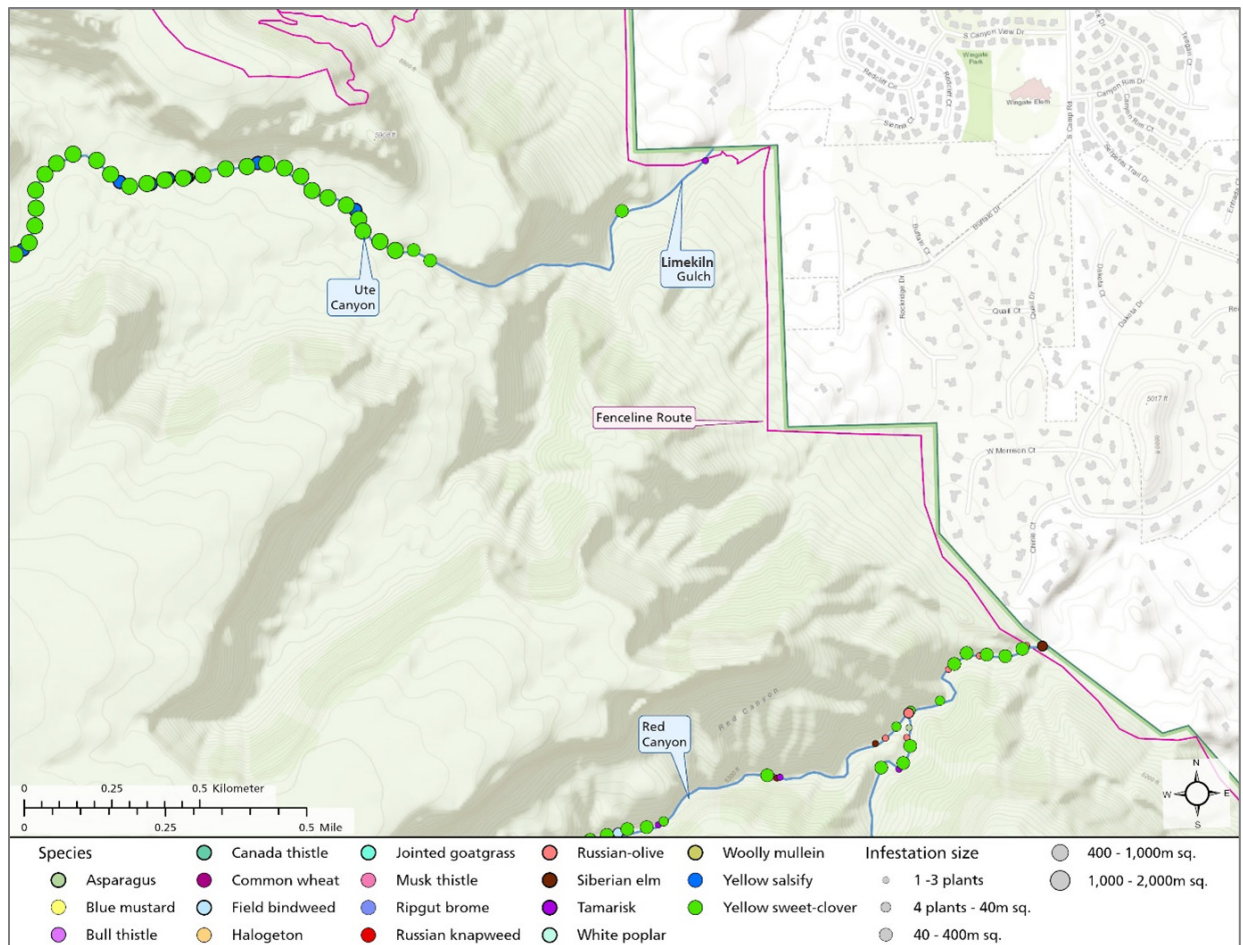


**Figure 11.** Invasive plants detected on monitoring routes in the vicinity of Limekiln Gulch, Colorado NM, June 5–12, 2024.

NPS / ANETH WIGHT

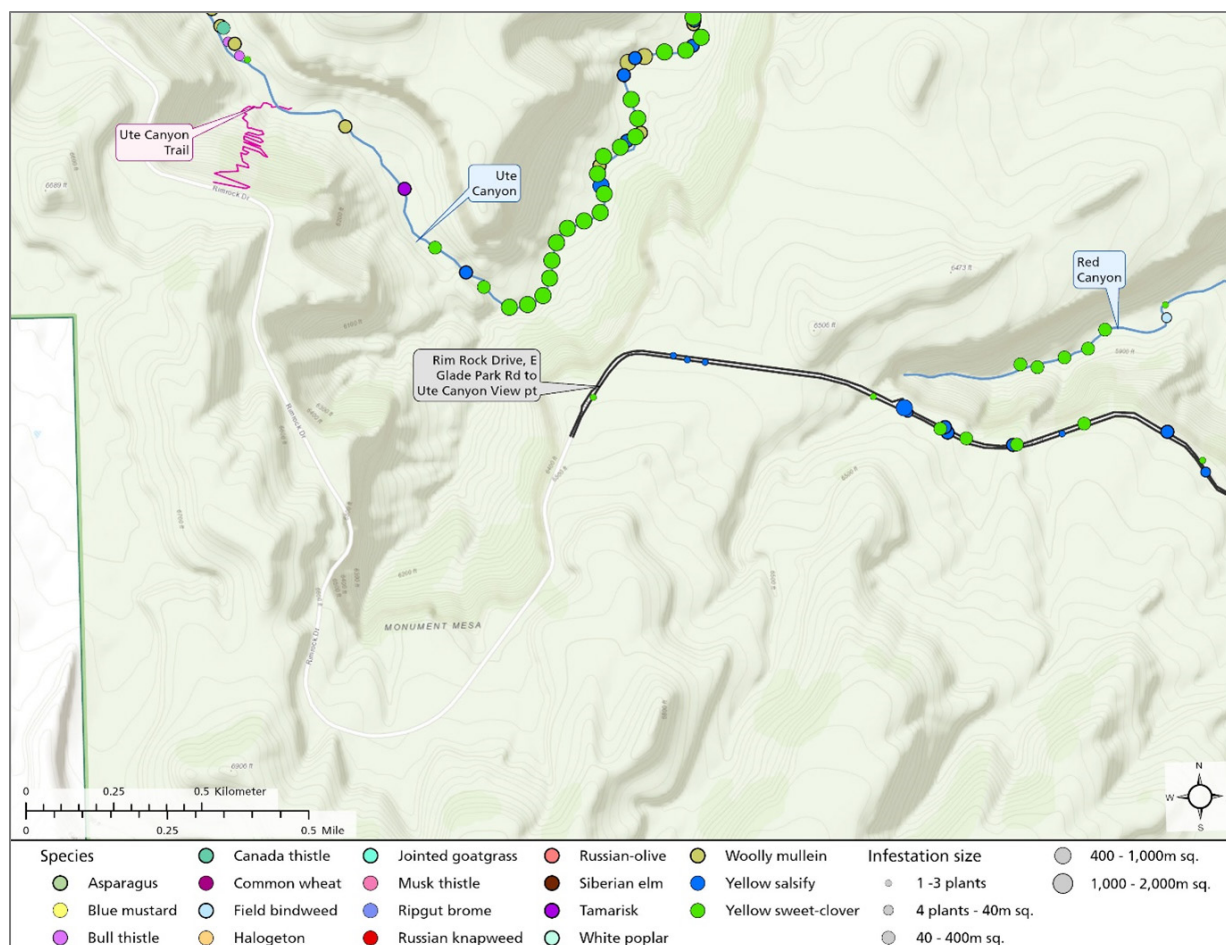


**Figure 12.** Invasive plants detected on monitoring routes in the vicinity Rim Rock Drive and the upper portion of Ute Canyon Trail, Colorado NM, June 5–12, 2024.

NPS / ANETH WIGHT

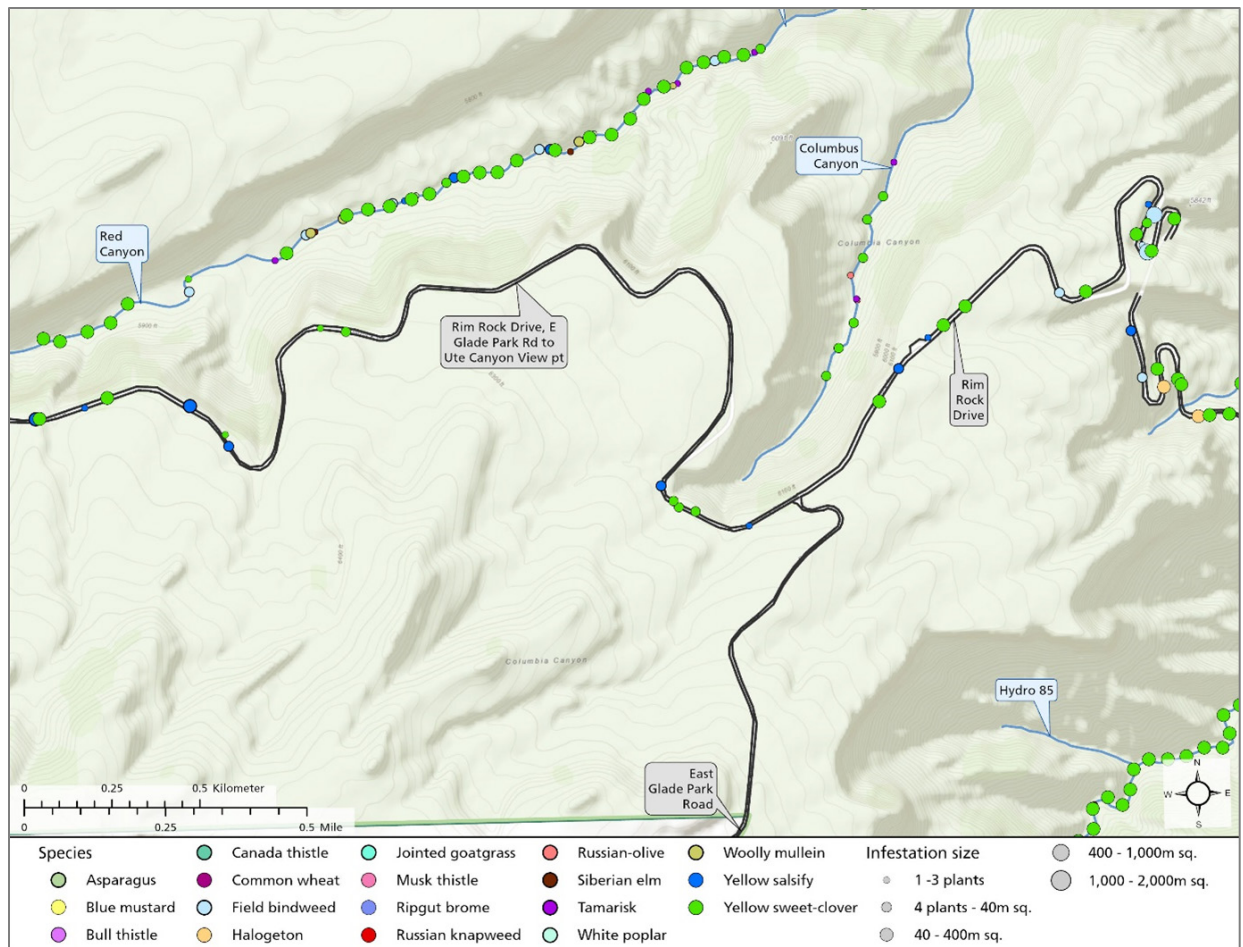


**Figure 13.** Invasive plants detected on monitoring routes in the vicinity of Red Canyon, Columbus Canyon and Rim Rock Drive, Colorado NM, June 5–12, 2024.

NPS / ANETH WIGHT

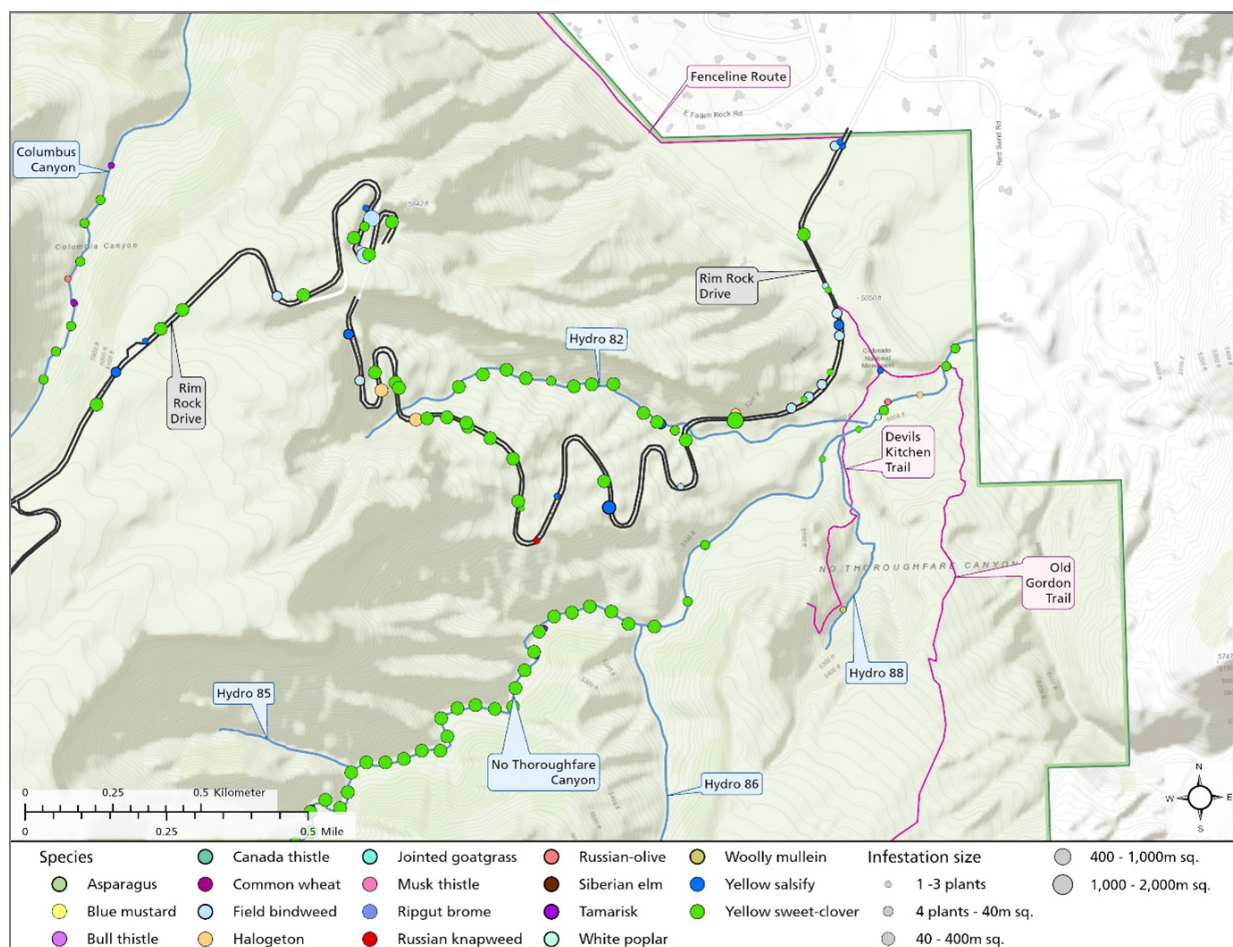


**Figure 14.** Invasive plants detected on monitoring routes in the vicinity of the Devil's Kitchen Trail, Colorado NM, June 5–12, 2024.

NPS / ANETH WIGHT

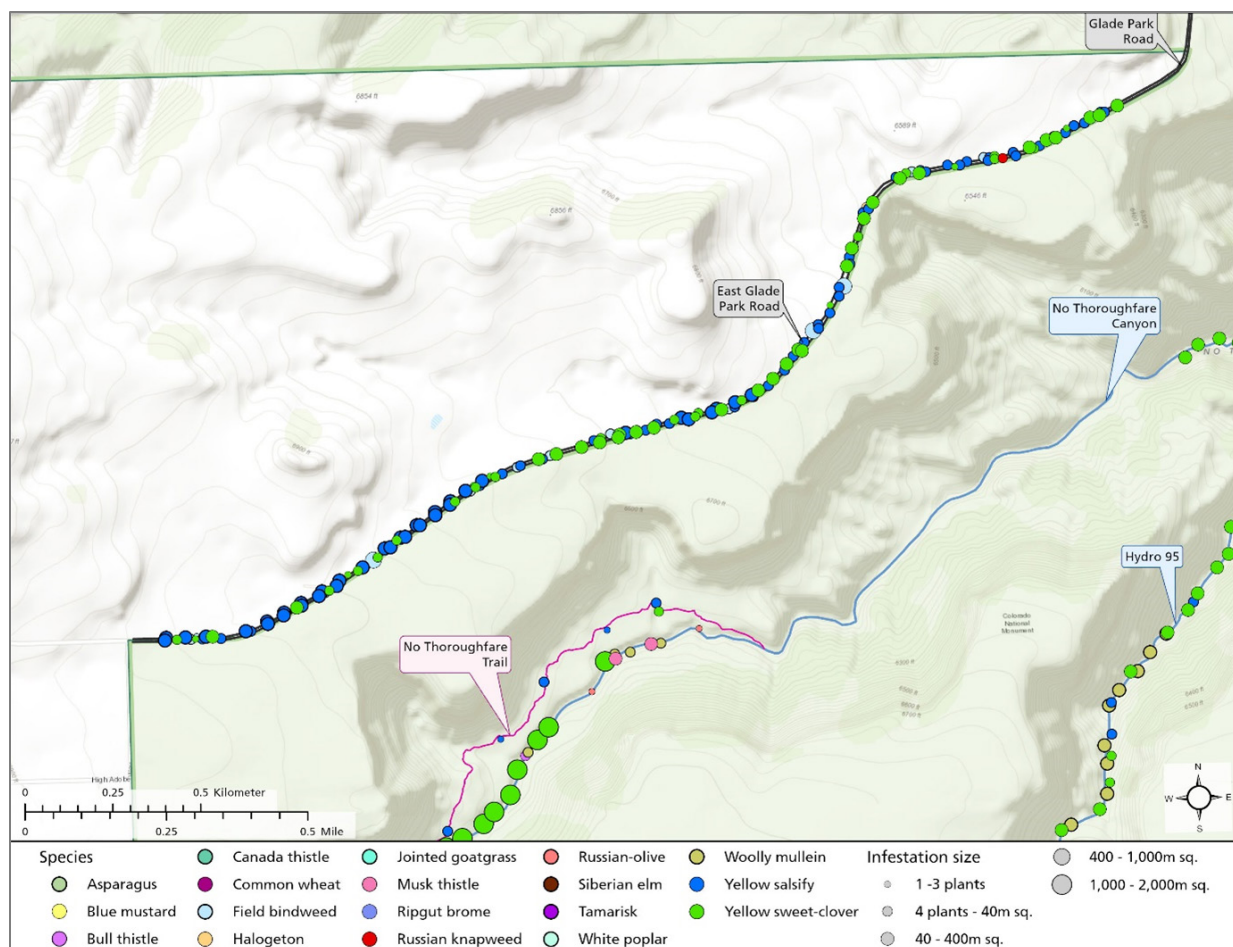


**Figure 15.** Invasive plants detected on monitoring routes near the western portion of East Glade Park Road, Colorado NM, June 5–12, 2024.

NPS / ANETH WIGHT

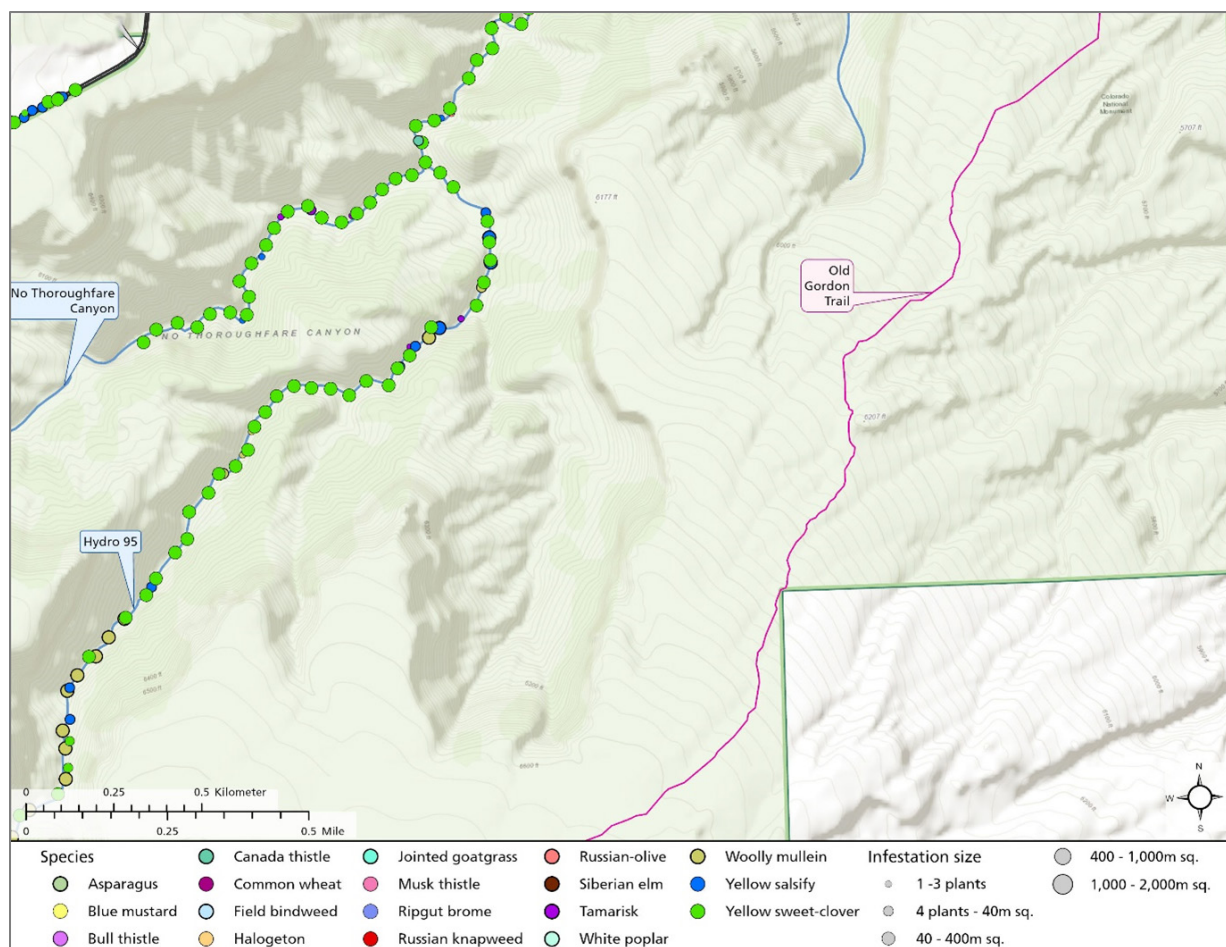


**Figure 16.** Invasive plants detected on monitoring routes in the vicinity of the central portion of No Thoroughfare Canyon, Colorado NM, June 5–12, 2024.

NPS / ANETH WIGHT

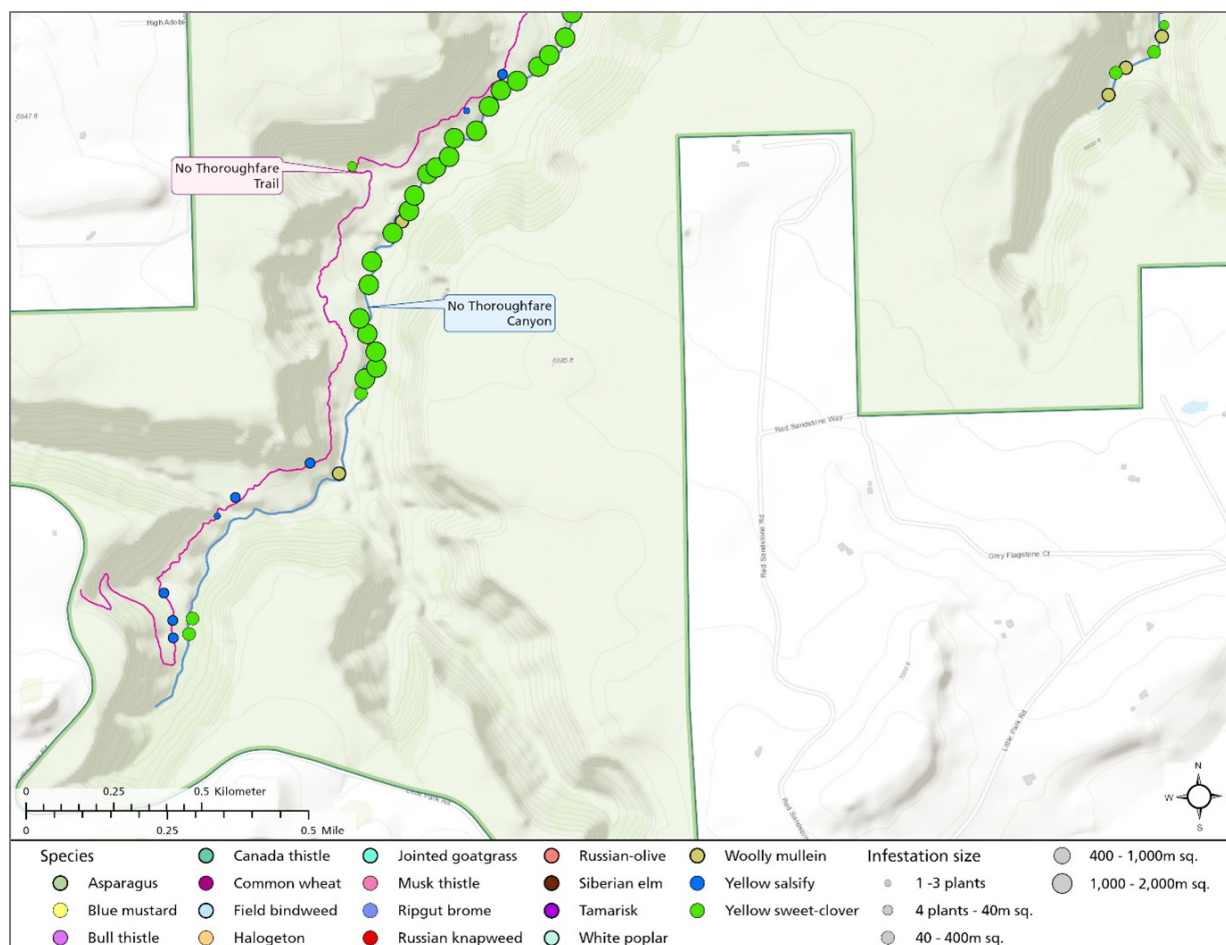


**Figure 17.** Invasive plants detected on monitoring routes in the vicinity of the western portion of No Thoroughfare Canyon, Colorado NM, June 5–12, 2024.

NPS/ANETH WIGHT

Along roads, the number of patches was much higher along the East Glade Park Road (21.94/km) compared to Rim Rock Drive (4.45/km) and Rim Rock Drive East (2.54/km). The most prevalent species on these roads was yellow sweet clover, which had 8.00 infestations/km, 2.22/km, and 1.17/km on East Glade Park Road, Rim Rock Drive, and Rim Rock Drive East, respectively.

Yellow sweet clover (*Melilotus officinalis*), yellow salsify (*Tragopogon dubius*), and ripgut brome (*Anisantha diandra*) were the most commonly detected priority IEPs, representing 87% of all priority patches along monitoring routes (Table 4). Only priority species should be examined when comparing across areas, as these were the only species consistently recorded by all observers.

Of the 797 priority patches, 547 (69%) were assigned to size classes larger than 40 m<sup>2</sup> (classes 3–5; see Table 4). Of these patches, 345 were yellow sweet clover (82% of patches of this species). Ripgut brome (*Anisantha diandra*) (88%) and woolly mullein (*Verbascum thapsus*) (73%) also had a large percentage of patches in the >40 m<sup>2</sup> size class.

Two priority tree species were detected: Russian olive (*Elaeagnus angustifolia*) and Siberian elm (*Ulmus pumila*). Of the 25 Russian olive patches detected, 9 were seedlings, 10 were saplings, and 6 were mature trees (NCPN 2025a). There were 3 seedlings, 4 saplings, and 1 mature Siberian elm. Siberian elm was found in Gold Star, Monument, No Thoroughfare and Red Canyons while Russian olive was found in Hydro 03, Fenceline, and Columbus, Monument, No Thoroughfare, and Red Canyons.

### **3.3 Monitoring Transects**

Transect data from routes where at least eight transects were conducted are summarized in Table 5 (see also NCPN 2025b). A total of 236 transects were sampled in 2024 (see NCPN 2025b). IEPs were found in 82% of transects surveyed. The most widespread IEP species in transects was cheatgrass, present in greater than 80% of transects across all routes. Percent cover of cheatgrass ranged from 0.04% to 6.28% across all areas, with it being highest in Wedding Canyon (6.28%), Fenceline (2.96%), Ute Canyon (2.58%), and Columbus/Red Canyon (1.90%). No other species had more than 0.70% cover on any route, with redstem filaree (*Erodium cicutarium*) being the next highest cover after cheatgrass with 0.64% in Ute Canyon. Generally, invasive species besides cheatgrass were present in 25% or fewer transects, except yellow sweet clover, which was present in 38% of transects in No Thoroughfare Canyon.

**Table 5.** Total number of transects per route, number of transects where exotic plant species were detected, mean percent cover by species, and standard error (SE) for routes with at least eight transects, Colorado National Monument, June 5–12, 2024.

| Route                        | Type     | Scientific name             | Common name      | # of transects detected/total transects | Percent cover | SE   |
|------------------------------|----------|-----------------------------|------------------|-----------------------------------------|---------------|------|
| Columbus/Red Canyon          | Riparian | <i>Anisantha tectorum</i>   | cheatgrass       | 12/12                                   | 1.90          | 1.58 |
| East Glade Park Road         | Road     | <i>Anisantha tectorum</i>   | cheatgrass       | 11/12                                   | 1.38          | 0.43 |
|                              | Road     | <i>Erodium cicutarium</i>   | red stem filaree | 2/12                                    | 0.04          | 0.03 |
|                              | Road     | <i>Salsola</i> sp.          | Russian thistle  | 3/12                                    | 0.25          | 0.20 |
|                              | Road     | <i>Tragopogon dubius</i>    | yellow salsify   | 1/12                                    | 0.08          | 0.09 |
|                              | Road     | All Species                 | –                | 11/12                                   | 1.81          | 0.52 |
| Fenceline                    | Trail    | <i>Anisantha tectorum</i>   | cheatgrass       | 28/31                                   | 2.96          | 0.81 |
|                              | Trail    | <i>Chorispora tenella</i>   | blue mustard     | 1/31                                    | 0.02          | 0.02 |
|                              | Trail    | <i>Erodium cicutarium</i>   | red stem filaree | 5/31                                    | 0.18          | 0.10 |
|                              | Trail    | <i>Halogeton glomeratus</i> | Halogeton        | 1/31                                    | 0.01          | 0.01 |
|                              | Trail    | <i>Salsola</i> sp.          | Russian thistle  | 4/31                                    | 0.05          | 0.02 |
|                              | Trail    | <i>Sisymbrium altissum</i>  | tumble mustard   | 7/31                                    | 0.07          | 0.03 |
|                              | Trail    | All Species                 | –                | 28/31                                   | 3.28          | 1.36 |
| Liberty Cap                  | Trail    | <i>Anisantha tectorum</i>   | cheatgrass       | 11/19                                   | 0.38          | 0.01 |
|                              | Trail    | <i>Tragopogon dubius</i>    | yellow salsify   | 1/19                                    | 0.01          | 0.01 |
|                              | Trail    | All Species                 | –                | 11/19                                   | 0.39          | 0.12 |
| Monument Canyon <sup>A</sup> | Riparian | <i>Anisantha diandra</i>    | ripgut brome     | 8/20                                    | 0.33          | 0.15 |
|                              | Riparian | <i>Anisantha tectorum</i>   | cheatgrass       | 16/20                                   | 0.79          | 0.24 |
|                              | Riparian | <i>Bromus japonicus</i>     | Japanese chess   | 1/20                                    | 0.01          | 0.01 |

<sup>A</sup> Includes Hydro 88.

<sup>B</sup> Includes Limekiln Gulch.

<sup>C</sup> Includes Hydros 82, 85, 86, and 95.

**Table 5 (continued).** Total number of transects per route, number of transects where exotic plant species were detected, mean percent cover by species, and standard error (SE) for routes with at least eight transects, Colorado National Monument, June 5–12, 2024.

| Route                                    | Type     | Scientific name              | Common name         | # of transects detected/total transects | Percent cover | SE   |
|------------------------------------------|----------|------------------------------|---------------------|-----------------------------------------|---------------|------|
| Monument Canyon (continued) <sup>A</sup> | Riparian | <i>Tragopogon dubius</i>     | yellow salsify      | 1/20                                    | 0.05          | 0.05 |
|                                          | Riparian | <i>Melilotus officinalis</i> | yellow sweet clover | 1/20                                    | 0.05          | 0.05 |
|                                          | Riparian | All Species                  | –                   | 18/20                                   | 1.23          | 0.46 |
| Monument Canyon Trail                    | Trail    | <i>Anisantha tectorum</i>    | cheatgrass          | 15/15                                   | 1.19          | 0.69 |
|                                          | Trail    | <i>Erodium cicutarium</i>    | red stem filaree    | 1/15                                    | 0.01          | 0.01 |
|                                          | Trail    | All Species                  | –                   | 15/15                                   | 1.20          | 0.71 |
| Ute Canyon <sup>B</sup>                  | Riparian | <i>Anisantha tectorum</i>    | cheatgrass          | 15/15                                   | 2.58          | 0.80 |
|                                          | Riparian | <i>Erodium cicutarium</i>    | red stem filaree    | 3/15                                    | 0.64          | 0.49 |
|                                          | Riparian | <i>Melilotus officinalis</i> | yellow sweet clover | 3/15                                    | 0.04          | 0.03 |
|                                          | Riparian | <i>Salsola</i> sp.           | Russian thistle     | 3/15                                    | 0.03          | 0.02 |
|                                          | Riparian | All Species                  | –                   | 15/15                                   | 3.30          | 1.34 |
| No Thoroughfare Canyon <sup>C</sup>      | Riparian | <i>Anisantha tectorum</i>    | cheatgrass          | 19/26                                   | 0.46          | 0.09 |
|                                          | Riparian | <i>Melilotus officinalis</i> | yellow sweet clover | 10/26                                   | 0.23          | 0.08 |
|                                          | Riparian | All Species                  | –                   | 22/26                                   | 0.65          | 0.11 |
| No Thoroughfare Canyon Trail             | Trail    | <i>Anisantha tectorum</i>    | cheatgrass          | 7/9                                     | 1.71          | 1.00 |
| Old Gordon Trail                         | Trail    | <i>Anisantha tectorum</i>    | cheatgrass          | 1/9                                     | 0.04          | 0.04 |
| Rim Rock Drive                           | Road     | <i>Anisantha tectorum</i>    | cheatgrass          | 22/23                                   | 0.84          | 0.13 |
|                                          | Road     | <i>Erodium cicutarium</i>    | red stem filaree    | 2/23                                    | 0.03          | 0.02 |
|                                          | Road     | <i>Halogeton glomeratus</i>  | Halogeton           | 1/23                                    | 0.02          | 0.02 |

<sup>A</sup> Includes Hydro 88.

<sup>B</sup> Includes Limekiln Gulch.

<sup>C</sup> Includes Hydros 82, 85, 86, and 95.

**Table 5 (continued).** Total number of transects per route, number of transects where exotic plant species were detected, mean percent cover by species, and standard error (SE) for routes with at least eight transects, Colorado National Monument, June 5–12, 2024.

| Route                                             | Type     | Scientific name           | Common name      | # of transects detected/total transects | Percent cover | SE   |
|---------------------------------------------------|----------|---------------------------|------------------|-----------------------------------------|---------------|------|
| Rim Rock Drive (continued)                        | Road     | <i>Tragopogon dubius</i>  | yellow salsify   | 1/23                                    | 0.03          | 0.03 |
|                                                   | Road     | All Species               | –                | 23/23                                   | 0.92          | 0.23 |
| Rim Rock Drive (E Glade to Ute Canyon View Point) | Road     | <i>Anisantha tectorum</i> | cheatgrass       | 12/20                                   | 0.28          | 0.07 |
| Wedding Canyon/Hydro 11                           | Riparian | <i>Anisantha tectorum</i> | cheatgrass       | 8/8                                     | 6.28          | 0.21 |
|                                                   | Riparian | <i>Erodium cicutarium</i> | red stem filaree | 2/8                                     | 0.04          | 0.03 |
|                                                   | Riparian | <i>Tragopogon dubius</i>  | yellow salsify   | 1/8                                     | 0.02          | 0.02 |
|                                                   | Riparian | All Species               | –                | 8/8                                     | 6.34          | 3.41 |

<sup>A</sup> Includes Hydro 88.

<sup>B</sup> Includes Limekiln Gulch.

<sup>C</sup> Includes Hydros 82, 85, 86, and 95.

### **3.4 Results Comparison: 2003–2024**

Colorado National Monument was previously surveyed for IEPs in 2003, 2009, 2011, 2013, 2015, 2017, 2019, and 2021 (Dewey and Andersen 2005; Perkins 2010, 2012, 2014, 2016, 2021, 2022; Gommermann et al. 2019).

The following IEP species were the most commonly observed from 2009 to 2024: bull thistle (*Cirsium vulgare*), Russian olive (*Elaeagnus angustifolia*), tamarisk, Siberian elm, yellow salsify, field bindweed, yellow sweet clover, and woolly mullein. Field bindweed, Russian olive, yellow sweet clover, woolly mullein, yellow salsify (in most areas), and Russian olive in Red Canyon all showed large increases in the number of patches per kilometer compared to the last sample period (Table 6). There were large increases in yellow sweet clover in No Thoroughfare, Red, and Ute Canyons, and in yellow salsify along East Glade Park Road. Many infestations per kilometer were the highest ever recorded from 2009 to 2024 for yellow sweet clover, woolly mullein, and yellow salsify.

**Table 6.** Invasive exotic plant species/km by route over all years of monitoring. ND = No data collected because this species was not on the priority list for that year, NS = Route was not sampled in that year.

| Scientific Name               | Common Name         | Route                                             | 2009 | 2011 | 2013 | 2015 | 2017 | 2019 | 2021 | 2024  |
|-------------------------------|---------------------|---------------------------------------------------|------|------|------|------|------|------|------|-------|
| <i>Descurainia sophia</i>     | flixweed            | Ute Canyon                                        | ND   | ND   | ND   | 0.00 | 0.12 | 0.13 | 0.00 | 0.00  |
| <i>Convolvulus arvensis</i>   | field bindweed      | Red Canyon                                        | 0.07 | 0.00 | 0.00 | 0.03 | 0.00 | 0.15 | 0.15 | 1.54  |
|                               | field bindweed      | Rimrock Drive                                     | 1.13 | 2.25 | 0.99 | NS   | 0.91 | NS   | NS   | 1.11  |
| <i>Elaeagnus angustifolia</i> | Russian olive       | No Thoroughfare Canyon <sup>A</sup>               | 0.14 | 0.05 | 0.00 | 0.05 | 0.02 | 0.01 | 0.02 | 0.72  |
|                               | Russian olive       | Red Canyon                                        | 0.00 | 0.03 | 0.00 | 0.00 | 0.10 | 0.00 | 0.07 | 1.54  |
| <i>Melilotus officinalis</i>  | yellow sweet clover | Columbus Canyon                                   | ND   | 9.57 | 9.57 | 5.63 | 1.57 | NS   | ND   | 5.03  |
|                               | yellow sweet clover | East Glade Park Road                              | ND   | 0.02 | 0.79 | 0.08 | NS   | 0.40 | ND   | 8.00  |
|                               | yellow sweet clover | No Thoroughfare Canyon <sup>A</sup>               | ND   | 0.95 | 0.60 | 0.86 | 0.88 | 1.09 | ND   | 10.75 |
|                               | yellow sweet clover | Monument Canyon                                   | ND   | 5.11 | 3.02 | 3.32 | 1.90 | NS   | ND   | 4.16  |
|                               | yellow sweet clover | Rim Rock Drive                                    | ND   | 5.45 | 1.82 | 2.69 | 3.79 | NS   | ND   | 2.39  |
|                               | yellow sweet clover | Rim Rock Drive (E Glade to Ute Canyon View Point) | ND   | 4.31 | 0.00 | NS   | 1.08 | NS   | ND   | 1.17  |
|                               | yellow sweet clover | Red Canyon                                        | ND   | 1.11 | 0.60 | 0.74 | 0.69 | 1.02 | ND   | 9.52  |
|                               | yellow sweet clover | Ute Canyon                                        | ND   | 0.91 | 0.48 | 1.08 | 1.13 | 1.01 | ND   | 17.37 |
|                               | yellow sweet clover | Wedding Canyon                                    | ND   | 4.00 | 0.24 | 0.47 | 0.44 | NS   | ND   | 1.69  |
| <i>Ulmus pumila</i>           | Siberian elm        | No Thoroughfare Canyon <sup>A</sup>               | 0.02 | 0.07 | 0.04 | 0.08 | 0.00 | 0.01 | 0.05 | 0.00  |
|                               | Siberian elm        | Red Canyon                                        | 0.07 | 0.08 | 0.12 | 0.05 | 0.00 | 0.15 | 0.17 | 1.29  |
| <i>Tamarix</i> spp.           | tamarisk            | No Thoroughfare Canyon <sup>A</sup>               | 0.08 | 0.08 | 0.04 | 0.03 | 0.03 | 0.04 | 0.06 | 0.00  |
|                               | tamarisk            | Ute Canyon                                        | 0.10 | 0.00 | 0.01 | 0.03 | 0.05 | 0.07 | 0.05 | 0.00  |
|                               | tamarisk            | Red Canyon                                        | 0.00 | 0.10 | 0.07 | 0.00 | 0.20 | 0.07 | 0.27 | 0.00  |
| <i>Verbascum thapsus</i>      | woolly mullein      | No Thoroughfare Canyon <sup>A</sup>               | 0.11 | 0.12 | 0.14 | 0.13 | 0.18 | 0.15 | 0.13 | 1.93  |
|                               | woolly mullein      | Red Canyon                                        | 0.10 | 0.03 | 0.12 | 0.28 | 0.34 | 0.17 | 0.22 | 1.03  |
|                               | woolly mullein      | Ute Canyon                                        | 0.05 | 0.01 | 0.08 | 0.19 | 0.15 | 0.04 | 0.04 | 1.79  |
| <i>Tragopogon dubius</i>      | yellow salsify      | Wedding Canyon                                    | ND   | ND   | ND   | 0.00 | 0.00 | ND   | 0.20 | 1.35  |
|                               | yellow salsify      | No Thoroughfare Canyon <sup>A</sup>               | ND   | ND   | ND   | 0.22 | 0.12 | 0.40 | 0.30 | 1.20  |

<sup>A</sup> Includes Hydros 82, 85, and 95.

**Table 6 (continued).** Invasive exotic plant species/km by route over all years of monitoring. ND = No data collected because this species was not on the priority list for that year, NS = Route was not sampled in that year.

| Scientific Name                         | Common Name       | Route                                             | 2009 | 2011 | 2013 | 2015 | 2017 | 2019 | 2021 | 2024  |
|-----------------------------------------|-------------------|---------------------------------------------------|------|------|------|------|------|------|------|-------|
| <i>Tragopogon dubius</i><br>(continued) | yellow salsify    | Monument Canyon                                   | ND   | ND   | ND   | 0.26 | 0.11 | ND   | 0.24 | 3.95  |
|                                         | yellow salsify    | Red Canyon                                        | ND   | ND   | ND   | 0.38 | 0.15 | 0.49 | 0.39 | 0.77  |
|                                         | yellow salsify    | Ute Canyon                                        | ND   | ND   | ND   | 0.65 | 0.52 | 0.52 | 0.48 | 4.96  |
|                                         | yellow salsify    | Liberty Cap Trail                                 | ND   | ND   | ND   | NS   | NS   | 0.00 | NS   | 1.11  |
|                                         | yellow salsify    | No Thoroughfare Trail                             | ND   | ND   | ND   | 0.22 | 0.12 | 0.40 | 0.30 | 2.60  |
|                                         | yellow salsify    | Fenceline                                         | ND   | ND   | ND   | 0.00 | NS   | 0.07 | NS   | 1.75  |
|                                         | yellow salsify    | East Glade Park Road                              | ND   | ND   | ND   | 0.24 | NS   | 0.47 | NS   | 11.70 |
|                                         | yellow salsify    | Rimrock Drive                                     | ND   | ND   | ND   | 2.08 | 1.73 | NS   | NS   | 0.77  |
|                                         | yellow salsify    | Rim Rock Drive (E Glade to Ute Canyon View Point) | ND   | ND   | ND   | NS   | 0.49 | NS   | NS   | 1.27  |
| <i>Cirsium vulgare</i>                  | bull thistle      | No Thoroughfare Canyon <sup>A</sup>               | 0.01 | 0.01 | 0.00 | 0.01 | 0.09 | 0.00 | 0.00 | 0.16  |
| <i>Cylindropyrum cylindricum</i>        | jointed goatgrass | Fruita Canyon                                     | ND   | 0.00 | 0.00 | 0.00 | 0.00 | ND   | 0.23 | 0.00  |
|                                         | jointed goatgrass | No Thoroughfare Canyon <sup>A</sup>               | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.05 | 0.00  |
|                                         | jointed goatgrass | Wedding Canyon                                    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | ND   | 0.66 | 0.00  |

<sup>A</sup> Includes Hydros 82, 85, and 95.

Tamarisk was not found in Colorado NM in 2024, indicating a decrease from the last sampling periods. Jointed goatgrass (*Cylindropyrum cylindricum*) also declined from 2021 in Fruita, No Thoroughfare, and Wedding Canyons.

The following priority IEP species were not detected during monitoring in 2024: diffuse knapweed (*Acosta diffusa*), spotted knapweed (*Acosta maculosa*), burdock (*Arctium minus*), hoary cress (*Cardaria* sp.), perennial pepperweed (*Cardaria latifolia*), plumeless thistle (*Carduus acanthoides*), common hound's tongue (*Cynoglossim officinale*), flixweed (*Descurainia sophia*), Dyer's woad (*Isatis tinctoria*), yellow starthistle (*Leucantha solstitialis*), yellow toadflax (*Linaria vulgaris*), purple loosestrife (*Lythrum salicaria*), common horehound (*Marrubium vulgare*), Scotch thistle (*Onopordum acanthium*), tamarisk, leafy spurge (*Tithymalus esula*), and puncture vine (*Tribulus terrestris*). Burdock, perennial pepperweed, Scotch thistle, tamarisk, and flixweed were detected in 2021 but not in 2024. However, Russian knapweed (*Acroptilon repens*) and musk thistle (*Carduus nutans*) were detected in 2024 for the first time during our monitoring. Halogeton (*Halogeton glomeratus*) was added to the priority list in 2024 and was detected.

## 4 Discussion

### 4.1 Priority IEP List

The NCPN will continue to work with Colorado NM staff and area IEP experts to review and update the list of priority species each year. Presence and absence data for priority IEP species are considered reliable for the area surveyed. Due to a miscommunication, yellow sweetclover was not included on the priority list in 2021, but it should have been. This species was added in 2023. The NCPN does not have any recommendations to add to the priority IEP list for future years.

### 4.2 Possibilities for Management Control

The routes with the highest priority IEP densities in 2024 were Ute Canyon, East Glade Park Road, Hydro 95, Monument Canyon, Red Canyon, and No Thoroughfare Canyon. IEP patches have increased substantially at No Thoroughfare Canyon, Red Canyon, Ute Canyon, Wedding Canyon, Rim Rock Drive, and East Glade Park Road.

Russian knapweed and musk thistle were found for the first time in our monitoring. Russian knapweed was found in one patch each along the East Glade Park Road, Monument Canyon, and Rim Rock Drive, while musk thistle was found in two patches in No Thoroughfare Canyon and one patch in Ute Canyon. In addition, there were small and isolated populations of bull thistle, Siberian elm, and Russian olive that could potentially be eradicated or at least easily controlled. It is also commendable that our monitoring found no infestations of tamarisk, which has been a focus of park control for years. Cheatgrass, yellow sweet clover, and yellow salsify are widespread and may be too widespread to control with current methods.

Estimates of percent cover in this report (see Table 5) are limited to the routes surveyed. Actual percent cover of IEPs across the entire park cannot be inferred with these methods. Because we monitor along areas most prone to invasion by a broad suite of IEPs, percent cover for most IEP species is probably lower in the interior of the park than along the monitoring routes.

### 4.3 Comparison of Sample Periods

Colorado NM was monitored for IEPs in 2003, 2009, 2011, 2013, 2015, 2017, 2019, 2021, and 2024. Because observers' judgment varies, mapping is subjective. For example, one observer may identify two small patches separated by 45 m (the patch separation rule is 50 m, but exact measurements are not made in the field) as two patches, while another observer may identify them as one large patch. Therefore, although general comparisons and species showing major differences between the survey periods are useful (if somewhat problematic) and likely represent biological differences, smaller changes may not reflect biologically important differences.

Many routes had the highest number of yellow sweet clover, woolly mullein, and yellow salsify infestations per kilometer ever recorded from 2009 to 2024 (see Table 6). In contrast, tamarisk was not found in Colorado NM in 2024, representing a decrease from the last sampling period. Jointed goatgrass also declined from 2021 in Fruita, No Thoroughfare, and Wedding Canyons.

#### **4.4 Future Monitoring Efforts**

Priority IEPs at Colorado NM will generally be monitored at the same time each year in future monitoring efforts. Consistency in the timing of monitoring should ensure consistency in detection probabilities and cover estimates of most species. For many species, sampling any time from May through September is not expected to significantly alter the chances of detecting invasive species larger than the MDTs. Extra-area surveys will also be considered for inventories at the park's request.

## 5 Literature Cited

- Dewey, S., and K. Andersen. 2005. An inventory of invasive non-native plants in Colorado National Monument (2003): Final report. Weed Science Research Project Report no. SD0516A. Plants, Soils, and Biometeorology Department, Utah State University, Logan, UT.  
<https://irma.nps.gov/DataStore/Reference/Profile/598532>
- Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 1998. Measuring and monitoring plant populations. USDI-BLM Technical Ref. 1730-1. Bureau of Land Management, Denver, Colorado. 477 pp. <https://irma.nps.gov/DataStore/Reference/Profile/624952>
- Executive order 13112. 1999. Invasive species. Federal register 64, no. 25 (February 8, 1999): 6183–86.
- Gommermann, L., D. W. Perkins, and A. Washuta. 2019. Invasive exotic plant monitoring in Colorado National Monument: 2017 field season. Natural resource report. NPS/NCPN/NRR—2019/1886. National Park Service, Fort Collins, Colorado.  
<https://irma.nps.gov/DataStore/Reference/Profile/2259514>
- Maxwell, S., R. A. Fuller, T. M. Brooks, and J. E. M. Watson. 2016. The ravages of guns, nets and bulldozers. *Nature* 536:143–145. <https://doi.org/10.1038/536143a>
- Mooney, H., and R. J. Hobbs, eds. 2000. *Invasive species in a changing world*. Washington, D.C.: Island Press. 457 pp.
- National Park Service (NPS). 1916. The National Park Service organic act of 1916. Washington, DC: U.S. Department of the Interior. <https://www.govinfo.gov/content/pkg/COMPS-1725/pdf/COMPS-1725.pdf>
- National Park Service, Northern Colorado Plateau Network (NCPN). 2025a. Exotic plant patches detected on monitoring routes at Colorado National Monument, 2024 [dataset]. National Park Service, Fort Collins, Colorado. <https://irma.nps.gov/DataStore/Reference/Profile/2314742>
- National Park Service, Northern Colorado Plateau Network (NCPN). 2025b. Exotic plant transect data detected at Colorado National Monument, 2024 [dataset]. National Park Service, Fort Collins, Colorado. <https://irma.nps.gov/DataStore/Reference/Profile/2314743>
- National Research Council (NRC). 2002. Predicting invasions of nonindigenous plants and plant pests. National Academy of Sciences, Washington, D.C.
- O'Dell, T., S. Garman, A. Evenden, M. Beer, E. Nance, D. Perry, R. DenBleyker, et al. 2005. Northern Colorado Plateau Inventory and Monitoring Network vital signs monitoring plan. National Park Service, Inventory and Monitoring Network, Moab, Utah. 174 pp. plus appendices.  
<https://irma.nps.gov/DataStore/Reference/Profile/579097>

- Perkins, D. W. 2010. Invasive exotic plant monitoring at Colorado National Monument, 2009. Natural Resource Technical Report NPS/NCPN/NRTR—2010/354. National Park Service, Fort Collins, Colorado. <https://irma.nps.gov/DataStore/Reference/Profile/2124894>
- Perkins, D. W. 2012. Invasive exotic plant monitoring in Colorado National Monument: 2011 field season. Natural Resource Technical Report NPS/NCPN/NRTR—2012/556. National Park Service, Fort Collins, Colorado. <https://irma.nps.gov/DataStore/Reference/Profile/2184180>
- Perkins, D. W. 2014. Invasive exotic plant monitoring in Colorado National Monument: 2013 field season. Natural Resource Technical Report NPS/NCPN/NRTR—2014/859. National Park Service, Fort Collins, Colorado. <https://irma.nps.gov/DataStore/Reference/Profile/2209084>
- Perkins, D. W. 2016. Invasive exotic plant monitoring in Colorado National Monument: 2015 field season. National Resource Technical report NPS/NCPN/NRTR—2016/1287. National Park Service, Fort Collins, Colorado. <https://irma.nps.gov/DataStore/Reference/Profile/2233029>
- Perkins, D. W. 2021. Invasive exotic plant monitoring at Colorado National Monument: 2019 field season. Natural Resource Report NPS/NCPN/NRR—2021/2268. National Park Service, Fort Collins, Colorado. <https://doi.org/10.36967/nrr-2286650>
- Perkins, D. W. 2022. Invasive exotic plant monitoring at Colorado National Monument: 2021 field season. Natural Resource Report NPS/NCPN/NRR—2022/2444. National Park Service, Fort Collins, Colorado. <https://doi.org/10.36967/2294260>
- Perkins, D. W., K. Edvarchuk, S. Dewey, H. Thomas, and A. Wight. 2016. Invasive exotic plant monitoring protocol narrative for Northern Colorado Plateau Network parks: version 1.02. <https://irma.nps.gov/DataStore/Reference/Profile/2236996>

National Park Service  
U.S. Department of the Interior



Science Report NPS/SR—2025/342  
<https://doi.org/10.36967/2314972>

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