



# Invasive Exotic Plant Monitoring at Fossil Butte National Monument

*2024 Field Season*



Vegetated ridges and open valleys stretch across the landscape in Fossil Butte National Monument.

NPS / AMY WASHUTA

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

Science Report NPS/SR—2025/350

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# Contents

|                                                                | Page |
|----------------------------------------------------------------|------|
| Figures.....                                                   | iv   |
| Tables.....                                                    | iv   |
| Abstract.....                                                  | v    |
| Acknowledgments.....                                           | vi   |
| 1 Introduction.....                                            | 1    |
| 2 Methods.....                                                 | 2    |
| 2.1 Developing a Park Priority Invasive Exotic Plant List..... | 2    |
| 2.2 Monitoring Routes.....                                     | 3    |
| 2.2.1 Minimum Detection Target Size .....                      | 4    |
| 2.2.2 Effective Detection Distance .....                       | 4    |
| 2.2.3 Effective Detection Swath Width .....                    | 5    |
| 2.2.4 Patch Separation Resolution.....                         | 5    |
| 2.2.5 Data Collection Methods.....                             | 5    |
| 2.3 Monitoring Transects and Quadrats .....                    | 6    |
| 2.4 Analyses .....                                             | 7    |
| 3 Results.....                                                 | 8    |
| 3.1 Priority Invasive Exotic Plant List .....                  | 8    |
| 3.2 Monitoring Routes.....                                     | 12   |
| 3.3 Monitoring Transects.....                                  | 14   |
| 3.4 Results Comparison: 2008–2024.....                         | 15   |
| 4 Discussion.....                                              | 35   |
| 4.1 Park Control Efforts and Species Response .....            | 35   |
| 4.2 Additional Invasive Plant Observations .....               | 36   |
| 5 Literature Cited .....                                       | 38   |

# Figures

|                                                                                                                                                                              | Page |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>Figure 1.</b> The maximum Effective Detection Distance (EDD) at Fossil Butte NM ranged from 5–8 m in 2024, making the Effective Detection Swath Width (EDSW) 10–16 m..... | 4    |
| <b>Figure 2.</b> Overview of invasive exotic plant monitoring routes surveyed at Fossil Butte NM, June 21–25, 2024.....                                                      | 9    |
| <b>Figure 3.</b> Invasive plants detected on monitoring routes in the northern portion of Fossil Butte NM, June 21–25, 2024. ....                                            | 10   |
| <b>Figure 4.</b> Invasive plants detected on monitoring routes in the central portion of Fossil Butte NM, June 21–25, 2024. ....                                             | 11   |
| <b>Figure 5.</b> Invasive plants detected on monitoring routes in the southern portion of Fossil Butte NM, June 21–25, 2024. ....                                            | 12   |

# Tables

|                                                                                                                                                                                                                        | Page |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>Table 1.</b> Priority invasive plant list, Fossil Butte NM, 2008–2024.....                                                                                                                                          | 2    |
| <b>Table 2.</b> Invasive exotic plants detected at Fossil Butte National Monument, June 21–25, 2024.....                                                                                                               | 8    |
| <b>Table 3.</b> Monitoring routes surveyed, route type, length, number of priority IEP infestations, and number of infestations/km, Fossil Butte NM, June 21–25, 2024. ....                                            | 13   |
| <b>Table 4.</b> Species observed and infestation size class detected along all monitoring routes, Fossil Butte NM, June 21–25, 2024.....                                                                               | 14   |
| <b>Table 5.</b> Number of monitoring transects where exotic plant species were detected/total number of transects monitored, mean percent cover, and standard error by area at Fossil Butte NM, June 21–25, 2024. .... | 15   |
| <b>Table 6.</b> Monitoring routes surveyed by species, year, total patches, and patch size class, Fossil Butte NM, 2008–2024.....                                                                                      | 16   |
| <b>Table 7.</b> Total number of patches (number per km) detected parkwide, in Northern drainages, Southern drainages, main park road, other roads, and trails in Fossil Butte National Monument, 2008–2021. ....       | 24   |

## 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 monitoring protocols implemented as part of its long-term monitoring program. This report represents work completed during the 2024 field season at Fossil Butte National Monument (NM). From June 23 to 25, 2024, we recorded 14 priority IEP species during monitoring in 812 patches along 65.1 km (40.4 mi) of 25 monitoring routes. Cheatgrass (*Bromus tectorum*) and creeping foxtail (*Alopecurus ventricosus*) were by far the most widespread priority species, representing 68% of all priority patches detected. Cheatgrass was the most frequently detected species, found on 23 of 137 transects. The only route with no priority IEPs detected in 2024 was Eagle Nest Point Road. In previous surveys in 2021, Fossil Butte Northwest, Wasatch Saddle, and the North Dam Fork of Chicken Creek drainages all had no priority IEPs detected. Common hound's tongue (*Cynoglossum officinale*), woolly mullein (*Verbascum thapsus*), and sowthistle (*Sonchus* sp.) were detected along our monitoring routes for the first time despite being on the priority list since monitoring began in 2008. The highest densities of IEP patches were detected along Main Park Road and several drainages: Main Park Road (22.1 patches/km), West Fork Chicken Creek (18.1 patches/km), Chicken Creek (16.3 patches/km), North Dam Fork Chicken Creek (15.1 patches/km), East Red Hill Drainage (12.1 patches/km), and Smallpox Creek (10.1 patches/km). Cheatgrass has increased along the Main Park Road but has been relatively stable park-wide with decreases along park trails, northern and southern drainages. Quackgrass (*Elymus repens*), black henbane (*Hyoscyamus niger*), yellow sweet-clover (*Melilotus officinalis*), and musk thistle (*Carduus nutans*) have all increased along Main Park Road. The number of patches per kilometer of creeping foxtail has varied over time. The number of infestations in 2024 (3.69 patches/km) was lower than 2021 (5.13 patches/km), but it was still the second-highest number of infestations per km over the eight sample periods. Quackgrass increased dramatically from 2021 to 2024, with black henbane and yellow sweet-clover also increasing. Rates of infestations per kilometer have remained low along roads other than Main Park Road and along trails. Control efforts by park staff are likely contributing to the prevention of some IEP increases in the park.

## **Acknowledgments**

A. Washuta and A. Kelly conducted fieldwork. A. Wight was extremely helpful in generating routes, quadrats, and other GIS information. A. Aase assisted with reviewing the park's priority invasive plant list, arranging site logistics, and sharing data on control efforts. C. Livensperger and A. Aase improved this report with their thoughtful reviews. 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, 1999). 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, roads, and trails. 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 Fossil Butte 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 inference 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 Fossil Butte 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, Fossil Butte NM, 2008–2024.

| Scientific Name                      | Common Name      |
|--------------------------------------|------------------|
| <i>Alopecurus ventricosus</i>        | creeping foxtail |
| <i>Arctium minus</i>                 | burdock          |
| <i>Bassia scoparia</i>               | summer cypress   |
| <i>Bromus diandrus</i> <sup>A</sup>  | ripgut brome     |
| <i>Bromus japonicus</i> <sup>B</sup> | Japanese brome   |
| <i>Bromus tectorum</i> <sup>C</sup>  | cheatgrass       |
| <i>Cardaria</i> sp.                  | hoary cress      |
| <i>Carduus nutans</i>                | musk thistle     |

<sup>A</sup> Added to priority list in 2024.

<sup>B</sup> Added to priority list in 2016, referred to in Perkins (2015) as Japanese chess.

<sup>C</sup> Added to priority list in 2014.

<sup>D</sup> Added to priority list in 2012.

**Table 1 (continued).** Priority invasive plant list, Fossil Butte NM, 2008–2024.

| Scientific Name                         | Common Name           |
|-----------------------------------------|-----------------------|
| <i>Centaurea diffusa</i>                | diffuse knapweed      |
| <i>Centaurea maculosa</i>               | spotted knapweed      |
| <i>Centaurea repens</i>                 | Russian knapweed      |
| <i>Cirsium arvense</i>                  | Canada thistle        |
| <i>Cirsium vulgare</i>                  | bull thistle          |
| <i>Convolvulus arvensis</i>             | field bindweed        |
| <i>Cynoglossum officinale</i>           | common hound's-tongue |
| <i>Descurainia sophia</i> <sup>D</sup>  | flaxweed              |
| <i>Elymus repens</i>                    | quackgrass            |
| <i>Euphorbia esula</i> <sup>A</sup>     | leafy spurge          |
| <i>Hyoscyamus niger</i>                 | black henbane         |
| <i>Isatis tinctoria</i>                 | Dyer's woad           |
| <i>Lepidium latifolium</i>              | perennial pepperweed  |
| <i>Linaria dalmatica</i>                | Dalmatian toadflax    |
| <i>Melilotus officinalis</i>            | yellow sweet-clover   |
| <i>Onopordum acanthium</i> <sup>A</sup> | Scotch thistle        |
| <i>Sisymbrium irio</i> <sup>A</sup>     | London rocket         |
| <i>Sonchus</i> sp.                      | sowthistle            |
| <i>Tamarix</i> sp.                      | tamarisk              |
| <i>Verbascum thapsus</i>                | woolly mullein        |

<sup>A</sup> Added to priority list in 2024.

<sup>B</sup> Added to priority list in 2016, referred to in Perkins (2015) as Japanese chess.

<sup>C</sup> Added to priority list in 2014.

<sup>D</sup> Added to priority list in 2012.

Prior to the start of monitoring in 2024, NCPN and park staff reviewed the list of priority IEPs (Table 1) that was developed in 2008. We added Scotch thistle (*Onopordum acanthium*), leafy spurge (*Euphorbia esula*), London rocket (*Sisymbrium irio*), and ripgut brome (*Bromus diandrus*) to the priority list in 2024.

## 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 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 an 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.

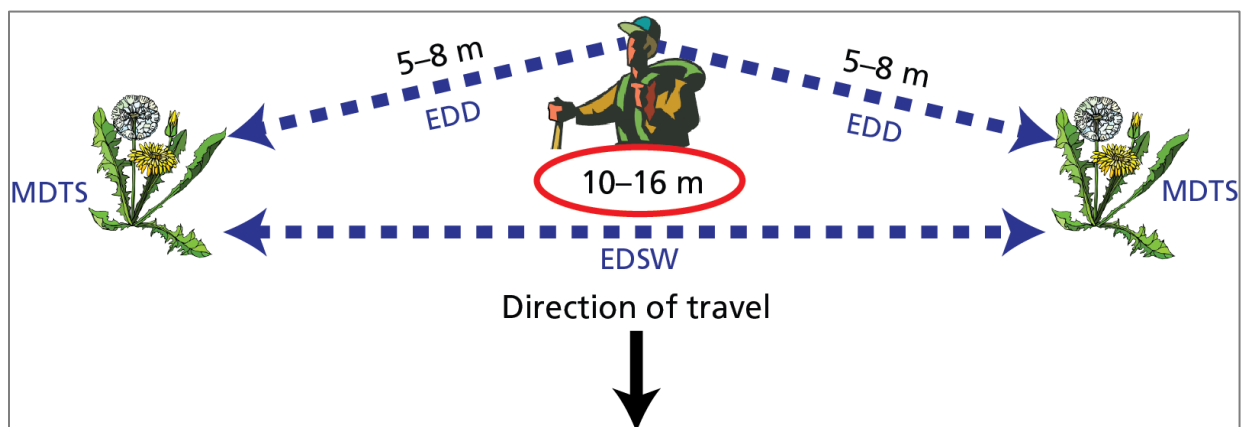


**Figure 1.** The maximum Effective Detection Distance (EDD) at Fossil Butte NM ranged from 5–8 m in 2024, making the Effective Detection Swath Width (EDSW) 10–16 m.

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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 Fossil Butte NM was between 5 and 8 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 5 to 8 m at Fossil Butte 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, then 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**

For the Main Park Road, we walked one EDD out from one side of the road and then returned to the starting point by walking back one EDD from the road on the other side. For secondary roads, single-track trails, and drainages, we walked the center of the trail or drainage in only one direction, searching for priority IEPs by visually scanning side-to-side all the land within the EDSW. 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 5–8 m (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-meter 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.  $>1,000\text{--}2,000\text{ m}^2$  (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, old growth); 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. Beginning in 2010, we established transects with three vegetation quadrats every 500 m along monitoring routes. From 2010 to 2014, if no IEPs were detected for four consecutive transects (12 quadrats), then transects were established every 1,000 m. If invasive plants were found in categories greater than 1 for cover class or patch size class, then we went back to establishing transects every 500 m. From 2016 to 2024 transects were always completed every 500 m.

From 2010 to 2024, we centered vegetation quadrats at 0.5, 5, and 10 m away from the edge of a road on the same side as the route that was being walked and on alternating sides for riparian areas, small roads, or trails. We placed a  $1\text{-m}^2$  sampling frame to sample vegetation cover and soil surface features on the right side of the transect line as the technician walked the monitoring route. In some cases, we leveled the sampling frame by propping up quadrat corners. In other cases, quadrats could not be placed at 5 and 10 m due to safety concerns.

Quadrat-sampling methods differed slightly in 2008 and 2009. In 2008, we used three  $1\text{-m}^2$  vegetation quadrats, placed in a circular macroplot (Perkins and Weissinger 2009). In 2009, quadrats were placed at 3, 8, and 13 m away from the monitoring route. In 2008, all invasive species detected were recorded in monitoring quadrats. From 2009 to 2021, only priority species and cheatgrass were recorded in quadrats.

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 the 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 28 species identified as high priority at Fossil Butte 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 812 patches of 14 priority IEP species along 65.1 km (40.4 miles) of monitoring routes and 137 transects in 2024 (Table 2; Figures 2–5; NCPN 2025a).

**Table 2.** Invasive exotic plants detected at Fossil Butte National Monument, June 21–25, 2024.

| Scientific Name               | Common Name           | Method Detected   | Park Priority |
|-------------------------------|-----------------------|-------------------|---------------|
| <i>Alopecurus ventricosus</i> | creeping foxtail      | Routes, Transects | Yes           |
| <i>Bromus japonicus</i>       | Japanese brome        | Routes, Transects | Yes           |
| <i>Bromus tectorum</i>        | Cheatgrass            | Routes, Transects | Yes           |
| <i>Cardaria</i> sp.           | whitetop              | Routes, Transects | Yes           |
| <i>Carduus nutans</i>         | musk thistle          | Routes, Transects | Yes           |
| <i>Cirsium arvense</i>        | Canada thistle        | Routes, Transects | Yes           |
| <i>Convolvulus arvensis</i>   | field bindweed        | Routes            | Yes           |
| <i>Cynoglossum officinale</i> | common hound's tongue | Routes            | Yes           |
| <i>Dactylis glomerata</i>     | orchard grass         | Routes            | No            |
| <i>Descurainia sophia</i>     | flixweed              | Routes            | Yes           |
| <i>Elymus repens</i>          | quackgrass            | Routes, Transects | Yes           |
| <i>Hyoscyamus niger</i>       | black henbane         | Routes            | Yes           |
| <i>Melilotus officinalis</i>  | yellow sweet-clover   | Routes, Transects | Yes           |
| <i>Sonchus</i> sp.            | sowthistle            | Routes            | Yes           |
| <i>Verbascum thapsus</i>      | woolly mullein        | Routes            | Yes           |

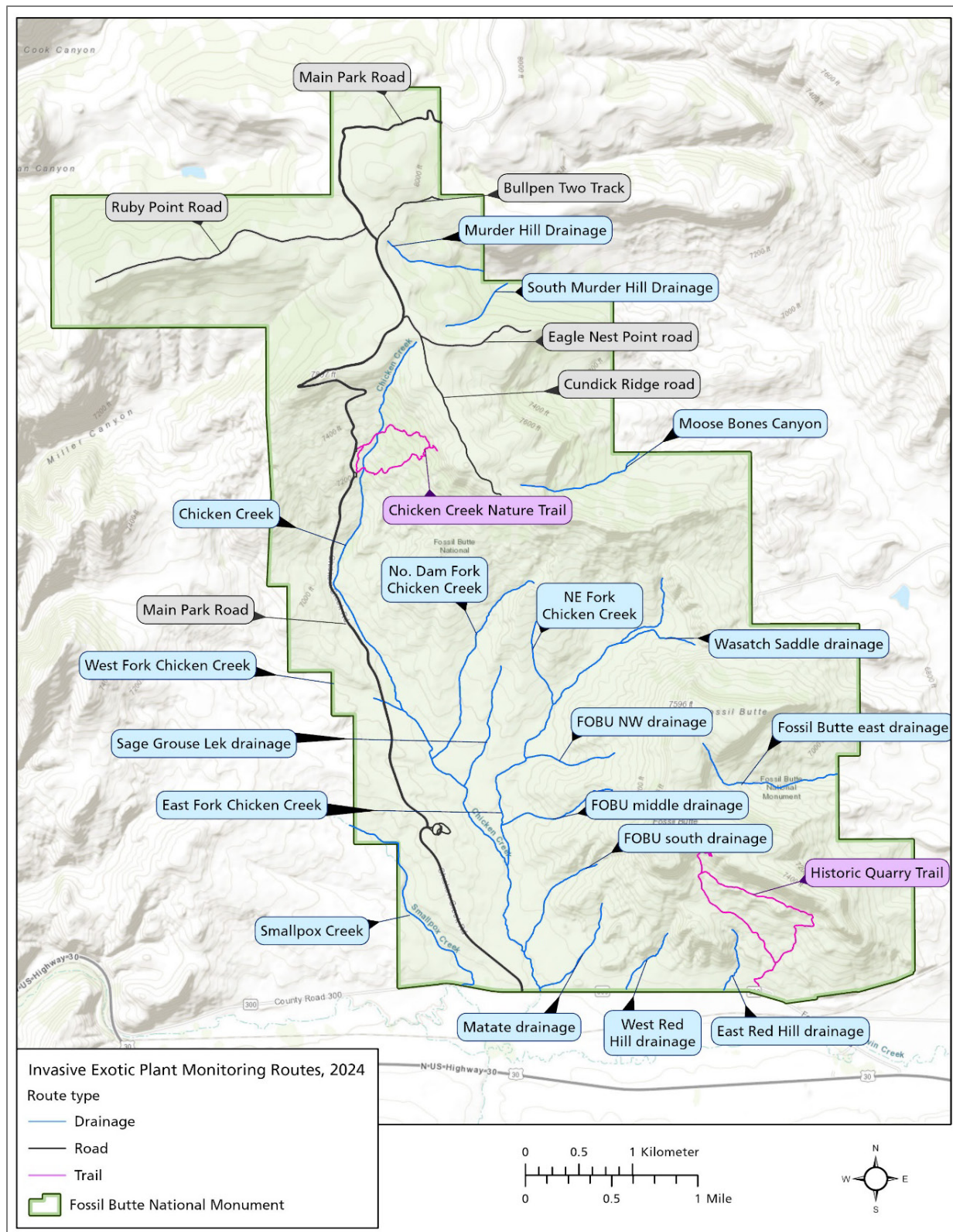


**Figure 2.** Overview of invasive exotic plant monitoring routes surveyed at Fossil Butte NM, June 21–25, 2024.

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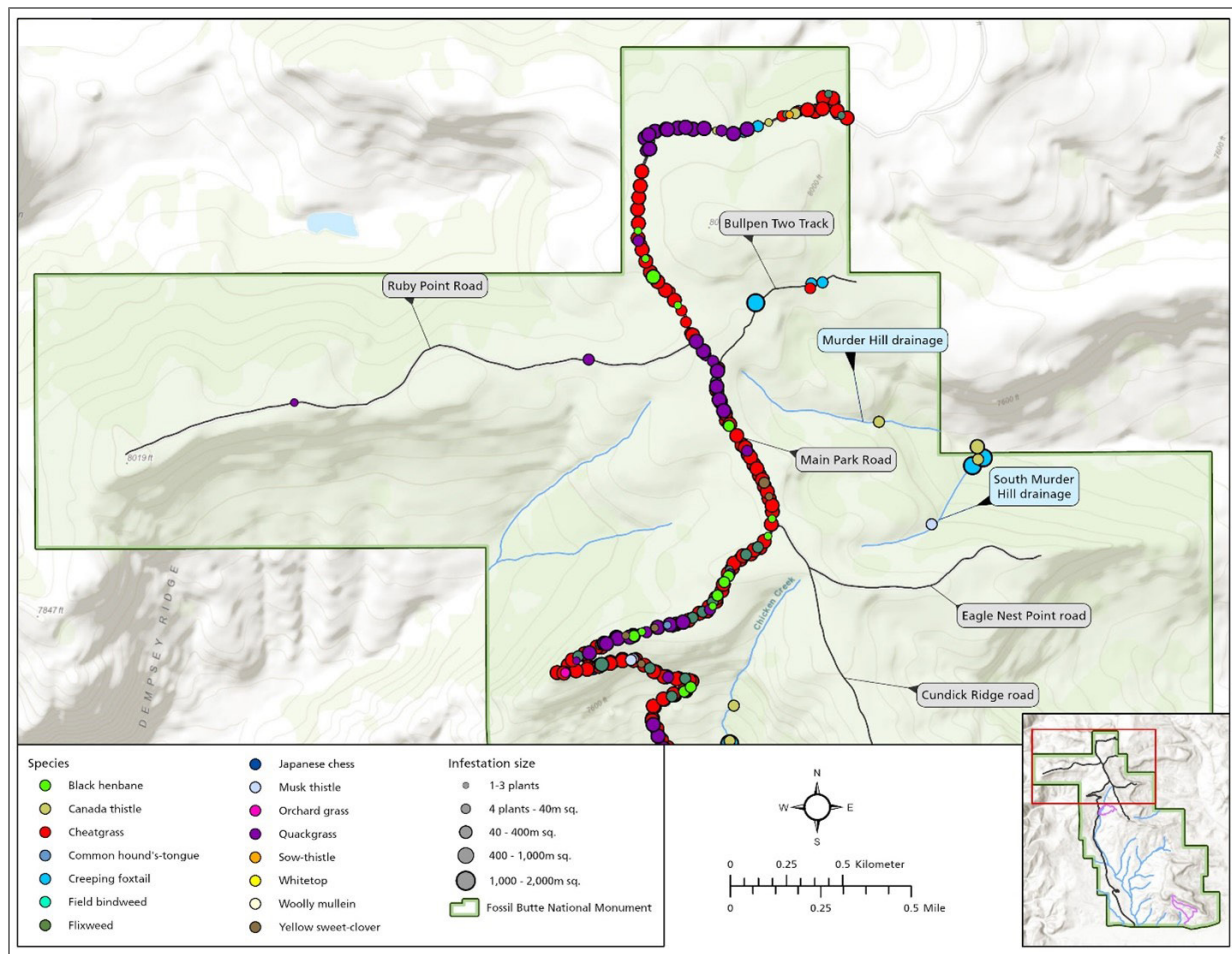


**Figure 3.** Invasive plants detected on monitoring routes in the northern portion of Fossil Butte NM, June 21–25, 2024.

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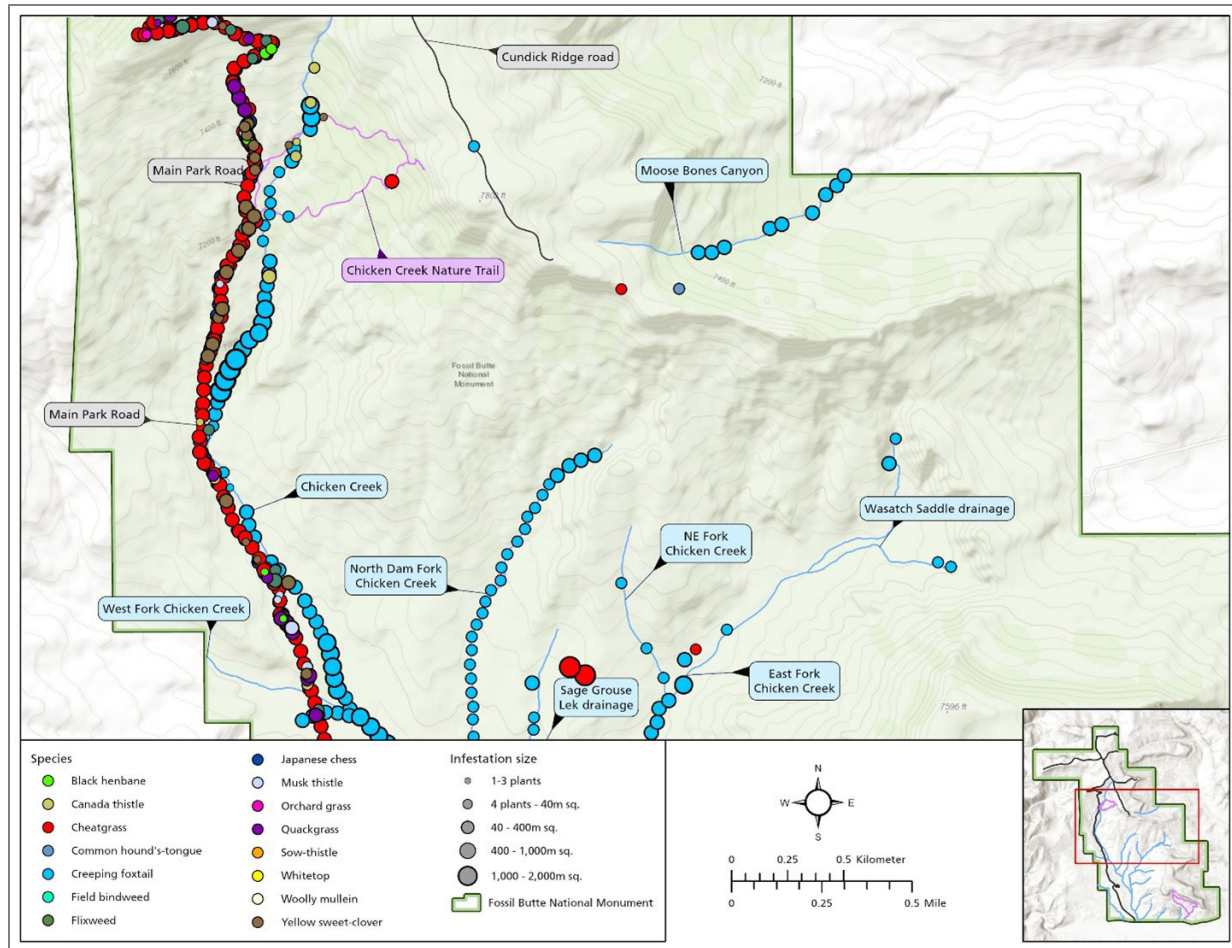


**Figure 4.** Invasive plants detected on monitoring routes in the central portion of Fossil Butte NM, June 21–25, 2024.

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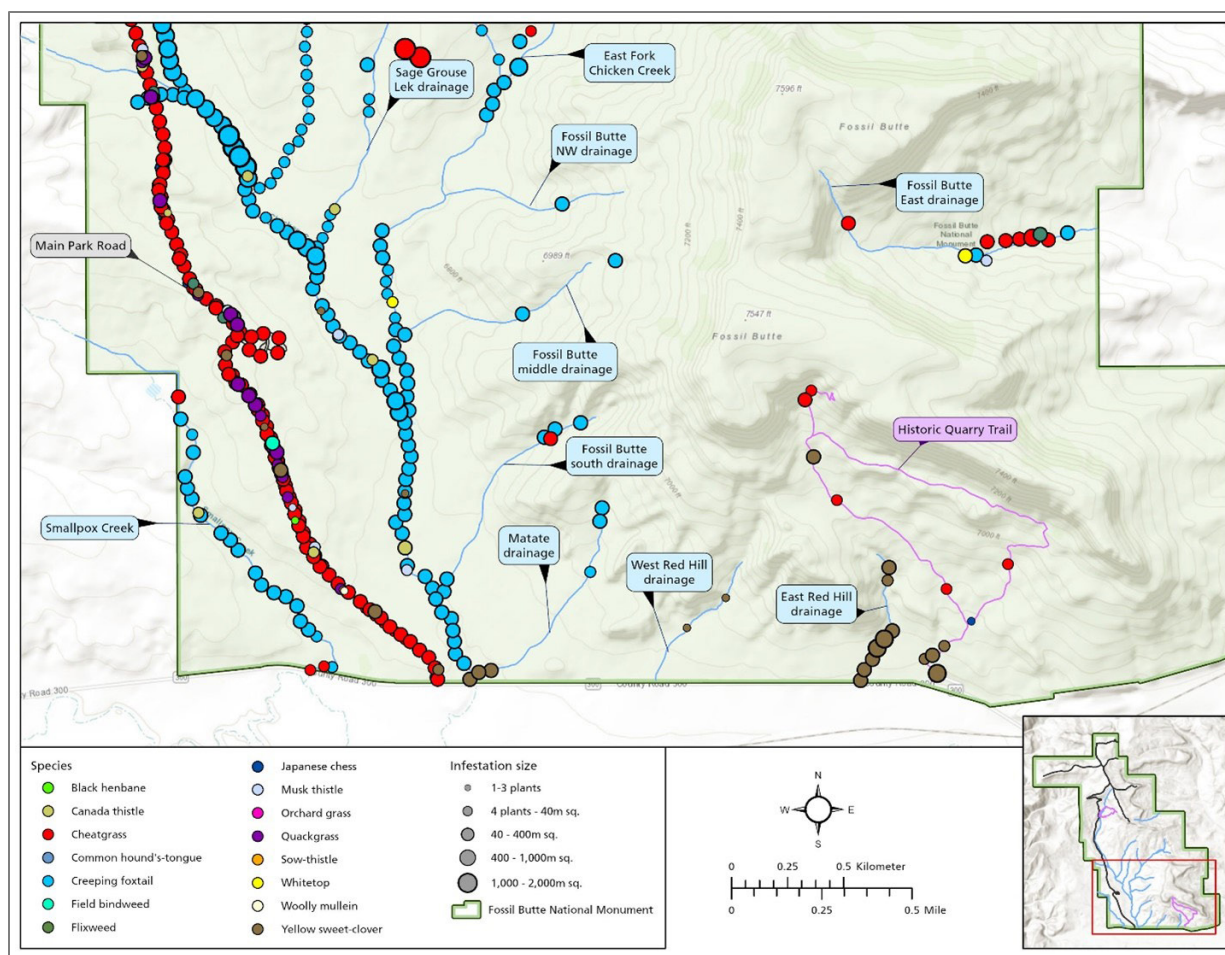


**Figure 5.** Invasive plants detected on monitoring routes in the southern portion of Fossil Butte NM, June 21–25, 2024.

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### 3.2 Monitoring Routes

Main Park Road (22.1/km), West Fork Chicken Creek (18.1/km), Chicken Creek (16.3/km), North Dam Fork Chicken Creek (15.1/km), East Red Hill Drainage (12.1/km), and Smallpox Creek (10.1/km) had the highest densities of IEP patches across all routes. Other routes had much lower patch densities (Table 3). Roads had the highest number of infestations per kilometer, but that was driven by the Main Park Road; the other roads had infestations had fewer than 5 infestations/km. Trails had the lowest number of infestations per km with riparian areas having a moderate amount.

The only route with no priority IEPs detected in 2024 was Eagle Nest Point Road. In previous surveys in 2021, Fossil Butte Northwest, Wasatch Saddle, and the North Dam Fork of Chicken Creek drainages all had no priority IEPs detected (see Table 3). Because of time constraints, Millet Canyon and South Millet Canyon routes were not completed in 2024.

**Table 3.** Monitoring routes surveyed, route type, length, number of priority IEP infestations, and number of infestations/km, Fossil Butte NM, June 21–25, 2024.

| Route                           | Type of Route | Length (km)   | # of Infestations | Infestations/km |
|---------------------------------|---------------|---------------|-------------------|-----------------|
| Chicken Creek                   | Riparian      | 7.198         | 118               | 16.39           |
| East Fork Chicken Creek         | Riparian      | 3.618         | 25                | 6.91            |
| East Red Hill Drainage          | Riparian      | 0.658         | 8                 | 12.15           |
| Fossil Butte Middle Drainage    | Riparian      | 1.179         | 3                 | 2.54            |
| Fossil Butte Northwest Drainage | Riparian      | 0.882         | 1                 | 1.13            |
| Fossil Butte Southern Drainage  | Riparian      | 1.161         | 6                 | 5.17            |
| Fossil Butte East Drainage      | Riparian      | 1.545         | 11                | 7.12            |
| Matate Drainage                 | Riparian      | 1.082         | 5                 | 4.62            |
| Murder Hill Drainage            | Riparian      | 0.981         | 1                 | 1.02            |
| Moose Bones Canyon              | Riparian      | 1.245         | 9                 | 7.23            |
| Northeast Fork Chicken Creek    | Riparian      | 0.836         | 3                 | 3.59            |
| North Dam Fork Chicken Creek    | Riparian      | 2.113         | 32                | 15.15           |
| Sage Grouse Lek Drainage        | Riparian      | 1.231         | 8                 | 6.50            |
| Smallpox Creek                  | Riparian      | 2.279         | 23                | 10.10           |
| South Murder Hill Drainage      | Riparian      | 0.744         | 5                 | 6.72            |
| Wasatch Saddle Drainage         | Riparian      | 0.788         | 2                 | 2.54            |
| West Fork Chicken Creek         | Riparian      | 0.298         | 5                 | 16.80           |
| West Red Hill Drainage          | Riparian      | 0.697         | 2                 | 2.87            |
| Bullpen Two Track               | Road          | 0.829         | 4                 | 4.82            |
| Cundick Ridge Road              | Road          | 2.005         | 1                 | 0.50            |
| Eagle Nest Point Road           | Road          | 1.130         | 0                 | 0.00            |
| Main Park Road                  | Road          | 23.542        | 518               | 22.00           |
| Ruby Point Road                 | Road          | 2.733         | 2                 | 0.73            |
| Chicken Creek Nature Trail      | Trail         | 2.391         | 5                 | 2.09            |
| Historic Quarry Trail           | Trail         | 3.902         | 11                | 2.82            |
| Between Routes                  | N/A           | N/A           | 4                 | N/A             |
| <b>All Riparian</b>             | –             | <b>28.535</b> | <b>267</b>        | <b>9.36</b>     |
| <b>All Roads</b>                | –             | <b>30.240</b> | <b>525</b>        | <b>17.36</b>    |
| <b>All Trails</b>               | –             | <b>6.293</b>  | <b>16</b>         | <b>2.54</b>     |
| <b>Total</b>                    | –             | <b>65.068</b> | <b>808</b>        | <b>12.42</b>    |

Cheatgrass (*Bromus tectorum*) and creeping foxtail (*Alopecurus ventricosus*) were by far the most widespread priority species, representing 68% of all priority patches detected (Table 4). Only 5% of all patches were larger than 400 m<sup>2</sup>, but 59% were between >40 and 400 m<sup>2</sup> (see Table 4). Cheatgrass (85%), quackgrass (*Elymus repens*) (60%), creeping foxtail (85%), and Japanese brome (*Bromus*

*japonicus*) (59%) had the largest percentage of patches in the >40–400 m<sup>2</sup> size class. One additional non-priority species, orchard grass (*Dactylis glomerata*), was recorded in one patch along the Main Park Road in the smallest size class.

**Table 4.** Species observed and infestation size class detected along all monitoring routes, Fossil Butte NM, June 21–25, 2024.

| Species                                | Total Infestations | 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>Alopecurus ventricosus</i>          | 240                | 6               | 75                           | 123                    | 28                       | 8                    |
| <i>Bromus japonicus</i>                | 32                 | 1               | 12                           | 19                     | 0                        | 0                    |
| <i>Bromus tectorum</i>                 | 310                | 0               | 44                           | 263                    | 1                        | 2                    |
| <i>Cardaria</i> sp.                    | 2                  | 0               | 1                            | 1                      | 0                        | 0                    |
| <i>Carduus nutans</i>                  | 19                 | 7               | 11                           | 1                      | 0                        | 0                    |
| <i>Cirsium arvense</i>                 | 24                 | 7               | 14                           | 3                      | 0                        | 0                    |
| <i>Convolvulus arvensis</i>            | 1                  | 0               | 0                            | 1                      | 0                        | 0                    |
| <i>Cynoglossum officinale</i>          | 2                  | 1               | 1                            | 0                      | 0                        | 0                    |
| <i>Dactylis glomerata</i> <sup>A</sup> | 1                  | 1               | 0                            | 0                      | 0                        | 0                    |
| <i>Descurainia sophia</i>              | 33                 | 6               | 22                           | 5                      | 0                        | 0                    |
| <i>Elymus repens</i>                   | 73                 | 3               | 26                           | 44                     | 0                        | 0                    |
| <i>Hyoscyamus niger</i>                | 20                 | 10              | 9                            | 1                      | 0                        | 0                    |
| <i>Melilotus officinalis</i>           | 55                 | 14              | 16                           | 22                     | 3                        | 0                    |
| <i>Sonchus</i> sp.                     | 1                  | 1               | 0                            | 0                      | 0                        | 0                    |
| <i>Verbascum thapsus</i>               | 1                  | 1               | 0                            | 0                      | 0                        | 0                    |
| <b>Total</b>                           | <b>813</b>         | <b>58</b>       | <b>231</b>                   | <b>483</b>             | <b>32</b>                | <b>10</b>            |
| <b>Priority Species, Total</b>         | <b>812</b>         | <b>57</b>       | <b>231</b>                   | <b>483</b>             | <b>32</b>                | <b>10</b>            |

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

Common hound’s tongue (*Cynoglossum officinale*), woolly mullein (*Verbascum thapsus*), and field sowthistle (*Sonchus* sp.) were detected along our monitoring routes for the first time despite being on the priority list since the beginning of monitoring in 2008. One common hound’s tongue was found on the Main Park Road, and a second was found while traversing between routes. The sowthistle and woolly mullein patches were both found on the Main Park Road. Summer cypress (*Bassia scoparia*) was detected for the first time during our monitoring at Fossil Butte NM along the Main Park Road in 2021. However, this species was not found in 2024.

### 3.3 Monitoring Transects

We found eight priority species in 137 transects sampled in 2024 (Table 5; NCPN 2025b). Cheatgrass was the most commonly detected species, occurring on 23 transects. Creeping foxtail, yellow sweet-clover (*Melilotus officinalis*), and Japanese brome were recorded on 7, 3, and 2 transects, respectively. Four other species were recorded in one transect each. A total of 36 transects had at least

one IEP species present. The average cover of IEP species across all transects in the park was 0.6% (SE = 0.2). Transects along the Main Park Road accounted for the majority of IEP occurrences, with 22 of 46 transects containing at least one IEP priority species, but total cover was only 0.26% (SD = 0.08) on that route.

**Table 5.** Number of monitoring transects where exotic plant species were detected/total number of transects monitored, mean percent cover, and standard error by area at Fossil Butte NM, June 21–25, 2024.

| Species                       | Detected / Total | Percent Cover (SE) |
|-------------------------------|------------------|--------------------|
| <i>Alopecurus ventricosus</i> | 7/137            | 0.01 (0.01)        |
| <i>Bromus japonicus</i>       | 2/137            | <0.01 (<0.01)      |
| <i>Bromus tectorum</i>        | 23/137           | 0.06 (0.01)        |
| <i>Cardaria</i> sp.           | 1/137            | 0.01 (0.01)        |
| <i>Carduus nutans</i>         | 1/137            | <0.01 (<0.01)      |
| <i>Cirsium arvense</i>        | 1/137            | 0.07 (0.07)        |
| <i>Elymus repens</i>          | 1/137            | 0.02 (0.02)        |
| <i>Melilotus officinalis</i>  | 3/137            | 0.02 (0.01)        |
| <b>All Invasive Species</b>   | <b>36/137</b>    | <b>0.57 (0.21)</b> |

### 3.4 Results Comparison: 2008–2024

Fossil Butte National Monument was previously surveyed for IEPs in 2008–2009, 2010, 2012, 2014, 2016, 2018, 2021, and 2024 (Perkins 2010, 2011, 2013, 2015, 2017, 2022; Washuta and Perkins 2019). Only priority species were examined when comparing years and areas, as these were the only species that were consistently recorded by all observers. Overall, the number of priority patches per kilometer on the priority list since 2008 has increased over time, with 6.73 patches/km in 2024 compared to 5.14/km in 2021 and 4.24/km in 2008–09 (Tables 6 and 7). However, individual species showed both increases and decreases over time.

**Table 6.** Monitoring routes surveyed by species, year, total patches, and patch size class, Fossil Butte NM, 2008–2024. <sup>A</sup>

| Common Name<br>Scientific name                         | Year    | Total Patches<br>(per km) | Patch Size Class <sup>B</sup> |     |     |    |    |
|--------------------------------------------------------|---------|---------------------------|-------------------------------|-----|-----|----|----|
|                                                        |         |                           | 1                             | 2   | 3   | 4  | 5  |
| creeping foxtail<br><i>Alopecurus ventricosus</i>      | 2008–09 | 26 (0.43)                 | 12                            | 10  | 2   | 2  | 0  |
|                                                        | 2010    | 63 (0.96)                 | 33                            | 24  | 4   | 2  | 0  |
|                                                        | 2012    | 58 (0.88)                 | 1                             | 35  | 17  | 4  | 1  |
|                                                        | 2014    | 123 (1.86)                | 17                            | 49  | 40  | 10 | 7  |
|                                                        | 2016    | 188 (2.82)                | 16                            | 80  | 64  | 11 | 17 |
|                                                        | 2018    | 199 (3.05)                | 5                             | 76  | 68  | 17 | 33 |
|                                                        | 2021    | 229 (3.70)                | 5                             | 64  | 139 | 16 | 5  |
|                                                        | 2024    | 240 (3.69)                | 6                             | 75  | 123 | 28 | 8  |
| summer cypress<br><i>Bassia scoparia</i>               | 2021    | 2 (0.03)                  | 0                             | 2   | 0   | 0  | 0  |
|                                                        | 2024    | 0 (0.00)                  | 0                             | 0   | 0   | 0  | 0  |
| Japanese brome<br><i>Bromus japonicus</i> <sup>C</sup> | 2016    | 91 (1.37)                 | 3                             | 62  | 24  | 2  | 0  |
|                                                        | 2018    | 158 (2.39)                | 1                             | 37  | 103 | 16 | 1  |
|                                                        | 2021    | 103 (1.66)                | 0                             | 39  | 63  | 1  | 0  |
|                                                        | 2024    | 32 (0.49)                 | 1                             | 12  | 19  | 0  | 0  |
| cheatgrass<br><i>Bromus tectorum</i> <sup>D</sup>      | 2014    | 199 (3.01)                | 5                             | 89  | 66  | 22 | 17 |
|                                                        | 2016    | 337 (5.06)                | 6                             | 127 | 139 | 49 | 16 |

<sup>A</sup> Distances and dates surveyed were 60.44 km (July 14–15, 2008 and August 6–8, 2009), 65.35 km (July 24–28, 2010), 65.87 km (August 2–5, 2012), 66.03 km (July 19–22, 2014), 66.56 km (June 30–July 4, 2016), 66.82 km (June 28–July 1, 2018), 61.9 km June 26–29, 2021 and 65.068 km June 21–25, 2024.

<sup>B</sup> Patch size classes: 1 = 1–a few plants ( $\leq 2 \times 2$  m), 2 = few 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), 5 = >1,000–2,000 m<sup>2</sup>.

<sup>C</sup> Added to priority list in 2016.

<sup>D</sup> Added to priority list in 2014.

<sup>E</sup> Added to priority list in 2012.

<sup>F</sup> Does not include cheatgrass, flxweed, or Japanese brome because these species were added to the IEP priority list after the early monitoring years.

**Table 6 (continued).** Monitoring routes surveyed by year, species, length, number of priority IEP infestations (number of infestations/km), Fossil Butte NM, 2008–2024. <sup>A</sup>

| Common Name<br>Scientific name                                | Year    | Total Patches<br>(per km) | Patch Size Class <sup>B</sup> |     |     |    |    |
|---------------------------------------------------------------|---------|---------------------------|-------------------------------|-----|-----|----|----|
|                                                               |         |                           | 1                             | 2   | 3   | 4  | 5  |
| cheatgrass<br><i>Bromus tectorum</i> <sup>D</sup> (continued) | 2018    | 453 (6.96)                | 0                             | 54  | 256 | 51 | 92 |
|                                                               | 2021    | 312 (5.04)                | 0                             | 192 | 120 | 0  | 0  |
|                                                               | 2024    | 310 (4.76)                | 0                             | 44  | 263 | 1  | 2  |
| whitetop<br><i>Cardaria</i> sp.                               | 2008–09 | 2 (0.03)                  | 1                             | 1   | 0   | 0  | 0  |
|                                                               | 2010    | 1 (0.02)                  | 0                             | 1   | 0   | 0  | 0  |
|                                                               | 2012    | 0 (0.00)                  | 0                             | 0   | 0   | 0  | 0  |
|                                                               | 2014    | 1 (0.02)                  | 0                             | 1   | 0   | 0  | 0  |
|                                                               | 2016    | 7 (0.11)                  | 2                             | 4   | 1   | 0  | 0  |
|                                                               | 2018    | 6 (0.09)                  | 0                             | 4   | 2   | 0  | 0  |
|                                                               | 2021    | 1 (0.02)                  | 0                             | 1   | 0   | 0  | 0  |
|                                                               | 2024    | 2 (0.03)                  | 1                             | 1   | 0   | 0  | 0  |
| musk thistle<br><i>Carduus nutans</i>                         | 2008–09 | 33 (0.46)                 | 22                            | 11  | 0   | 0  | 0  |
|                                                               | 2010    | 37 (0.57)                 | 24                            | 7   | 5   | 1  | 0  |
|                                                               | 2012    | 19 (0.29)                 | 6                             | 11  | 1   | 1  | 0  |
|                                                               | 2014    | 30 (0.45)                 | 18                            | 10  | 1   | 1  | 0  |
|                                                               | 2016    | 17 (0.26)                 | 9                             | 6   | 1   | 0  | 0  |

<sup>A</sup> Distances and dates surveyed were 60.44 km (July 14–15, 2008 and August 6–8, 2009), 65.35 km (July 24–28, 2010), 65.87 km (August 2–5, 2012), 66.03 km (July 19–22, 2014), 66.56 km (June 30–July 4, 2016), 66.82 km (June 28–July 1, 2018), 61.9 km June 26–29, 2021 and 65.068 km June 21–25, 2024.

<sup>B</sup> Patch size classes: 1 = 1–a few plants ( $\leq 2 \times 2$  m), 2 = few 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), 5 = >1,000–2,000 m<sup>2</sup>.

<sup>C</sup> Added to priority list in 2016.

<sup>D</sup> Added to priority list in 2014.

<sup>E</sup> Added to priority list in 2012.

<sup>F</sup> Does not include cheatgrass, flaxweed, or Japanese brome because these species were added to the IEP priority list after the early monitoring years.

**Table 6 (continued).** Monitoring routes surveyed by year, species, length, number of priority IEP infestations (number of infestations/km), Fossil Butte NM, 2008–2024. <sup>A</sup>

| Common Name<br>Scientific name                    | Year    | Total Patches<br>(per km) | Patch Size Class <sup>B</sup> |    |    |   |   |
|---------------------------------------------------|---------|---------------------------|-------------------------------|----|----|---|---|
|                                                   |         |                           | 1                             | 2  | 3  | 4 | 5 |
| musk thistle<br><i>Carduus nutans</i> (continued) | 2018    | 14 (0.21)                 | 7                             | 7  | 0  | 0 | 0 |
|                                                   | 2021    | 4 (0.06)                  | 1                             | 3  | 0  | 0 | 0 |
|                                                   | 2024    | 19 (0.29)                 | 7                             | 11 | 1  | 0 | 0 |
| spotted knapweed<br><i>Centaurea maculosa</i>     | 2008–09 | 0 (0.00)                  | 0                             | 0  | 0  | 0 | 0 |
|                                                   | 2010    | 1 (0.02)                  | 0                             | 1  | 0  | 0 | 0 |
|                                                   | 2012    | 4 (0.06)                  | 2                             | 2  | 0  | 0 | 0 |
|                                                   | 2014    | 6 (0.09)                  | 1                             | 4  | 1  | 0 | 0 |
|                                                   | 2016    | 1 (0.02)                  | 1                             | 0  | 0  | 0 | 0 |
|                                                   | 2018    | 0 (0.00)                  | 0                             | 0  | 0  | 0 | 0 |
|                                                   | 2021    | 0 (0.00)                  | 0                             | 0  | 0  | 0 | 0 |
|                                                   | 2024    | 0 (0.00)                  | 0                             | 0  | 0  | 0 | 0 |
| Canada thistle<br><i>Cirsium arvense</i>          | 2008–09 | 89 (1.47)                 | 35                            | 40 | 11 | 3 | 0 |
|                                                   | 2010    | 54 (0.83)                 | 12                            | 30 | 10 | 2 | 0 |
|                                                   | 2012    | 9 (0.14)                  | 1                             | 6  | 1  | 1 | 0 |
|                                                   | 2014    | 19 (0.29)                 | 2                             | 12 | 4  | 1 | 0 |
|                                                   | 2016    | 27 (0.41)                 | 5                             | 20 | 1  | 1 | 0 |

<sup>A</sup> Distances and dates surveyed were 60.44 km (July 14–15, 2008 and August 6–8, 2009), 65.35 km (July 24–28, 2010), 65.87 km (August 2–5, 2012), 66.03 km (July 19–22, 2014), 66.56 km (June 30–July 4, 2016), 66.82 km (June 28–July 1, 2018), 61.9 km June 26–29, 2021 and 65.068 km June 21–25, 2024.

<sup>B</sup> Patch size classes: 1 = 1–a few plants ( $\leq 2 \times 2$  m), 2 = few 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), 5 = >1,000–2,000 m<sup>2</sup>.

<sup>C</sup> Added to priority list in 2016.

<sup>D</sup> Added to priority list in 2014.

<sup>E</sup> Added to priority list in 2012.

<sup>F</sup> Does not include cheatgrass, flaxweed, or Japanese brome because these species were added to the IEP priority list after the early monitoring years.

**Table 6 (continued).** Monitoring routes surveyed by year, species, length, number of priority IEP infestations (number of infestations/km), Fossil Butte NM, 2008–2024. <sup>A</sup>

| Common Name<br>Scientific name                       | Year    | Total Patches<br>(per km) | Patch Size Class <sup>B</sup> |    |   |   |   |
|------------------------------------------------------|---------|---------------------------|-------------------------------|----|---|---|---|
|                                                      |         |                           | 1                             | 2  | 3 | 4 | 5 |
| Canada thistle<br><i>Cirsium arvense</i> (continued) | 2018    | 18 (0.27)                 | 2                             | 15 | 1 | 0 | 0 |
|                                                      | 2021    | 27 (0.44)                 | 1                             | 21 | 5 | 0 | 0 |
|                                                      | 2024    | 24 (0.37)                 | 7                             | 14 | 3 | 0 | 0 |
| bull thistle<br><i>Cirsium vulgare</i>               | 2008–09 | 8 (0.13)                  | 6                             | 2  | 0 | 0 | 0 |
|                                                      | 2010    | 9 (0.14)                  | 6                             | 3  | 0 | 0 | 0 |
|                                                      | 2012    | 6 (0.09)                  | 2                             | 4  | 0 | 0 | 0 |
|                                                      | 2014    | 0 (0.00)                  | 0                             | 0  | 0 | 0 | 0 |
|                                                      | 2016    | 4 (0.06)                  | 2                             | 2  | 0 | 0 | 0 |
|                                                      | 2018    | 0 (0.00)                  | 0                             | 0  | 0 | 0 | 0 |
|                                                      | 2021    | 0 (0.00)                  | 0                             | 0  | 0 | 0 | 0 |
|                                                      | 2024    | 0 (0.00)                  | 0                             | 0  | 0 | 0 | 0 |
| field bindweed<br><i>Convolvulus arvensis</i>        | 2008–09 | 5 (0.06)                  | 0                             | 5  | 0 | 0 | 0 |
|                                                      | 2010    | 1 (0.02)                  | 0                             | 1  | 0 | 0 | 0 |
|                                                      | 2012    | 0 (0.00)                  | 0                             | 0  | 0 | 0 | 0 |
|                                                      | 2014    | 2 (0.03)                  | 0                             | 2  | 0 | 0 | 0 |
|                                                      | 2016    | 2 (0.03)                  | 0                             | 2  | 0 | 0 | 0 |

<sup>A</sup> Distances and dates surveyed were 60.44 km (July 14–15, 2008 and August 6–8, 2009), 65.35 km (July 24–28, 2010), 65.87 km (August 2–5, 2012), 66.03 km (July 19–22, 2014), 66.56 km (June 30–July 4, 2016), 66.82 km (June 28–July 1, 2018), 61.9 km June 26–29, 2021 and 65.068 km June 21–25, 2024.

<sup>B</sup> Patch size classes: 1 = 1–a few plants ( $\leq 2 \times 2$  m), 2 = few 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), 5 = >1,000–2,000 m<sup>2</sup>.

<sup>C</sup> Added to priority list in 2016.

<sup>D</sup> Added to priority list in 2014.

<sup>E</sup> Added to priority list in 2012.

<sup>F</sup> Does not include cheatgrass, flaxweed, or Japanese brome because these species were added to the IEP priority list after the early monitoring years.

**Table 6 (continued).** Monitoring routes surveyed by year, species, length, number of priority IEP infestations (number of infestations/km), Fossil Butte NM, 2008–2024. <sup>A</sup>

| Common Name<br>Scientific name                            | Year    | Total Patches<br>(per km) | Patch Size Class <sup>B</sup> |     |    |    |    |
|-----------------------------------------------------------|---------|---------------------------|-------------------------------|-----|----|----|----|
|                                                           |         |                           | 1                             | 2   | 3  | 4  | 5  |
| field bindweed<br><i>Convolvulus arvensis</i> (continued) | 2018    | 2 (0.03)                  | 0                             | 2   | 0  | 0  | 0  |
|                                                           | 2021    | 3 (0.05)                  | 0                             | 3   | 0  | 0  | 0  |
|                                                           | 2024    | 1 (0.02)                  | 0                             | 0   | 1  | 0  | 0  |
| common hound's tongue<br><i>Cynoglossum officinale</i>    | 2024    | 2 (0.02)                  | 1                             | 1   | 0  | 0  | 0  |
| flixweed<br><i>Descurainia sophia</i> <sup>E</sup>        | 2012    | 3 (0.50)                  | 2                             | 1   | 0  | 0  | 0  |
|                                                           | 2014    | 165 (2.50)                | 7                             | 103 | 26 | 8  | 21 |
|                                                           | 2016    | 81 (1.22)                 | 19                            | 57  | 5  | 0  | 0  |
|                                                           | 2018    | 55 (0.85)                 | 2                             | 35  | 13 | 2  | 3  |
|                                                           | 2021    | 36 (0.58)                 | 4                             | 28  | 4  | 0  | 0  |
|                                                           | 2024    | 33 (0.51)                 | 6                             | 22  | 5  | 0  | 0  |
| quackgrass<br><i>Elymus repens</i>                        | 2008–09 | 73 (1.21)                 | 20                            | 29  | 15 | 9  | 0  |
|                                                           | 2010    | 95 (1.45)                 | 12                            | 31  | 29 | 16 | 7  |
|                                                           | 2012    | 23 (0.35)                 | 1                             | 18  | 3  | 1  | 0  |
|                                                           | 2014    | 5 (0.08)                  | 1                             | 4   | 0  | 0  | 0  |
|                                                           | 2016    | 31 (0.47)                 | 2                             | 25  | 4  | 0  | 0  |

<sup>A</sup> Distances and dates surveyed were 60.44 km (July 14–15, 2008 and August 6–8, 2009), 65.35 km (July 24–28, 2010), 65.87 km (August 2–5, 2012), 66.03 km (July 19–22, 2014), 66.56 km (June 30–July 4, 2016), 66.82 km (June 28–July 1, 2018), 61.9 km June 26–29, 2021 and 65.068 km June 21–25, 2024.

<sup>B</sup> Patch size classes: 1 = 1–a few plants ( $\leq 2 \times 2$  m), 2 = few 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), 5 = >1,000–2,000 m<sup>2</sup>.

<sup>C</sup> Added to priority list in 2016.

<sup>D</sup> Added to priority list in 2014.

<sup>E</sup> Added to priority list in 2012.

<sup>F</sup> Does not include cheatgrass, flixweed, or Japanese brome because these species were added to the IEP priority list after the early monitoring years.

**Table 6 (continued).** Monitoring routes surveyed by year, species, length, number of priority IEP infestations (number of infestations/km), Fossil Butte NM, 2008–2024. <sup>A</sup>

| Common Name<br>Scientific name                 | Year    | Total Patches<br>(per km) | Patch Size Class <sup>B</sup> |    |    |   |   |
|------------------------------------------------|---------|---------------------------|-------------------------------|----|----|---|---|
|                                                |         |                           | 1                             | 2  | 3  | 4 | 5 |
| quackgrass<br><i>Elymus repens</i> (continued) | 2018    | 20 (0.30)                 | 0                             | 11 | 9  | 0 | 0 |
|                                                | 2021    | 5 (0.31)                  | 0                             | 5  | 0  | 0 | 0 |
|                                                | 2024    | 73 (1.12)                 | 3                             | 26 | 44 | 0 | 0 |
| black henbane<br><i>Hyoscyamus niger</i>       | 2008–09 | 19 (0.31)                 | 17                            | 1  | 1  | 0 | 0 |
|                                                | 2010    | 5 (0.02)                  | 4                             | 1  | 0  | 0 | 0 |
|                                                | 2012    | 4 (0.06)                  | 0                             | 4  | 0  | 0 | 0 |
|                                                | 2014    | 4 (0.06)                  | 1                             | 3  | 0  | 0 | 0 |
|                                                | 2016    | 10 (0.15)                 | 4                             | 6  | 0  | 0 | 0 |
|                                                | 2018    | 3 (0.04)                  | 3                             | 0  | 0  | 0 | 0 |
|                                                | 2021    | 9 (0.15)                  | 3                             | 6  | 0  | 0 | 0 |
|                                                | 2024    | 20 (0.31)                 | 10                            | 9  | 1  | 0 | 0 |
| Dyer's woad<br><i>Isatis tinctoria</i>         | 2008–09 | 2 (0.02)                  | 2                             | 0  | 0  | 0 | 0 |
|                                                | 2010    | 0 (0.00)                  | 0                             | 0  | 0  | 0 | 0 |
|                                                | 2012    | 0 (0.00)                  | 0                             | 0  | 0  | 0 | 0 |
|                                                | 2014    | 0 (0.00)                  | 0                             | 0  | 0  | 0 | 0 |
|                                                | 2016    | 0 (0.00)                  | 0                             | 0  | 0  | 0 | 0 |

<sup>A</sup> Distances and dates surveyed were 60.44 km (July 14–15, 2008 and August 6–8, 2009), 65.35 km (July 24–28, 2010), 65.87 km (August 2–5, 2012), 66.03 km (July 19–22, 2014), 66.56 km (June 30–July 4, 2016), 66.82 km (June 28–July 1, 2018), 61.9 km June 26–29, 2021 and 65.068 km June 21–25, 2024.

<sup>B</sup> Patch size classes: 1 = 1–a few plants ( $\leq 2 \text{ m}$ ), 2 = few 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), 5 = >1,000–2,000 m<sup>2</sup>.

<sup>C</sup> Added to priority list in 2016.

<sup>D</sup> Added to priority list in 2014.

<sup>E</sup> Added to priority list in 2012.

<sup>F</sup> Does not include cheatgrass, flaxweed, or Japanese brome because these species were added to the IEP priority list after the early monitoring years.

**Table 6 (continued).** Monitoring routes surveyed by year, species, length, number of priority IEP infestations (number of infestations/km), Fossil Butte NM, 2008–2024. <sup>A</sup>

| Common Name<br>Scientific name                      | Year    | Total Patches<br>(per km) | Patch Size Class <sup>B</sup> |    |    |   |   |
|-----------------------------------------------------|---------|---------------------------|-------------------------------|----|----|---|---|
|                                                     |         |                           | 1                             | 2  | 3  | 4 | 5 |
| Dyer's woad<br><i>Isatis tinctoria</i> (continued)  | 2018    | 0 (0.00)                  | 0                             | 0  | 0  | 0 | 0 |
|                                                     | 2021    | 0 (0.00)                  | 0                             | 0  | 0  | 0 | 0 |
|                                                     | 2024    | 0 (0.00)                  | 0                             | 0  | 0  | 0 | 0 |
| yellow sweet-clover<br><i>Melilotus officinalis</i> | 2008–09 | 56 (0.93)                 | 39                            | 10 | 5  | 2 | 0 |
|                                                     | 2010    | 54 (0.83)                 | 28                            | 21 | 5  | 0 | 0 |
|                                                     | 2012    | 10 (0.15)                 | 3                             | 6  | 1  | 0 | 0 |
|                                                     | 2014    | 20 (0.30)                 | 9                             | 9  | 2  | 0 | 0 |
|                                                     | 2016    | 23 (0.35)                 | 12                            | 11 | 0  | 0 | 0 |
|                                                     | 2018    | 21 (0.31)                 | 3                             | 12 | 6  | 0 | 0 |
|                                                     | 2021    | 32 (0.52)                 | 6                             | 18 | 8  | 0 | 0 |
|                                                     | 2024    | 55 (0.84)                 | 14                            | 16 | 22 | 3 | 0 |
| sowthistle<br><i>Sonchus</i> sp.                    | 2024    | 1 (0.02)                  | 1                             | 0  | 0  | 0 | 0 |
| woolly mullein<br><i>Verbascum thapsus</i>          | 2024    | 1 (0.02)                  | 1                             | 0  | 0  | 0 | 0 |

<sup>A</sup> Distances and dates surveyed were 60.44 km (July 14–15, 2008 and August 6–8, 2009), 65.35 km (July 24–28, 2010), 65.87 km (August 2–5, 2012), 66.03 km (July 19–22, 2014), 66.56 km (June 30–July 4, 2016), 66.82 km (June 28–July 1, 2018), 61.9 km June 26–29, 2021 and 65.068 km June 21–25, 2024.

<sup>B</sup> Patch size classes: 1 = 1–a few plants ( $\leq 2 \times 2$  m), 2 = few 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), 5 = >1,000–2,000 m<sup>2</sup>.

<sup>C</sup> Added to priority list in 2016.

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<sup>E</sup> Added to priority list in 2012.

<sup>F</sup> Does not include cheatgrass, flxweed, or Japanese brome because these species were added to the IEP priority list after the early monitoring years.

**Table 6 (continued).** Monitoring routes surveyed by year, species, length, number of priority IEP infestations (number of infestations/km), Fossil Butte NM, 2008–2024. <sup>A</sup>

| Common Name<br>Scientific name                                           | Year    | Total Patches<br>(per km) | Patch Size Class <sup>B</sup> |     |     |    |    |
|--------------------------------------------------------------------------|---------|---------------------------|-------------------------------|-----|-----|----|----|
|                                                                          |         |                           | 1                             | 2   | 3   | 4  | 5  |
| All priority species<br>monitoring over all time<br>periods <sup>F</sup> | 2008–09 | 314 (5.21)                | 154                           | 109 | 35  | 16 | 0  |
|                                                                          | 2010    | 320 (4.90)                | 119                           | 120 | 53  | 21 | 7  |
|                                                                          | 2012    | 133 (2.02)                | 16                            | 86  | 23  | 7  | 1  |
|                                                                          | 2014    | 375 (5.68)                | 56                            | 197 | 74  | 20 | 28 |
|                                                                          | 2016    | 310 (4.66)                | 53                            | 156 | 71  | 13 | 17 |
|                                                                          | 2018    | 281 (4.21)                | 19                            | 125 | 87  | 17 | 33 |
|                                                                          | 2021    | 312 (5.04)                | 16                            | 123 | 152 | 16 | 5  |
|                                                                          | 2024    | 438 (6.73)                | 51                            | 151 | 195 | 31 | 6  |

<sup>A</sup> Distances and dates surveyed were 60.44 km (July 14–15, 2008 and August 6–8, 2009), 65.35 km (July 24–28, 2010), 65.87 km (August 2–5, 2012), 66.03 km (July 19–22, 2014), 66.56 km (June 30–July 4, 2016), 66.82 km (June 28–July 1, 2018), 61.9 km June 26–29, 2021 and 65.068 km June 21–25, 2024.

<sup>B</sup> Patch size classes: 1 = 1–a few plants ( $\leq 2 \times 2$  m), 2 = few 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), 5 = >1,000–2,000 m<sup>2</sup>.

<sup>C</sup> Added to priority list in 2016.

<sup>D</sup> Added to priority list in 2014.

<sup>E</sup> Added to priority list in 2012.

<sup>F</sup> Does not include cheatgrass, flaxweed, or Japanese brome because these species were added to the IEP priority list after the early monitoring years.

**Table 7.** Total number of patches (number per km) detected parkwide, in Northern drainages, Southern drainages, main park road, other roads, and trails in Fossil Butte National Monument, 2008–2021. Species with fewer than 5 occurrences over the sampling periods are not listed. Distances in km for different groupings: 65.08 All Park, ND = 2.97, SD = 25.565, MPR = 23.542, Road = 6.697, Trails = 6.293.

| Common Name<br>Scientific name                         | Year      | Total Patches (per km) |                                 |                                 |                |                          |                     |
|--------------------------------------------------------|-----------|------------------------|---------------------------------|---------------------------------|----------------|--------------------------|---------------------|
|                                                        |           | Parkwide               | Northern Drainages <sup>A</sup> | Southern Drainages <sup>B</sup> | Main Park Road | Other Roads <sup>C</sup> | Trails <sup>D</sup> |
| creeping foxtail<br><i>Alopecurus ventricosus</i>      | 2008–2009 | 24 (0.40)              | 2 (0.41)                        | 22 (0.87)                       | 0 (0.00)       | 0 (0.00)                 | 0 (0.00)            |
|                                                        | 2010      | 63 (0.96)              | 8 (1.75)                        | 43 (1.70)                       | 6 (0.27)       | 2 (0.29)                 | 4 (0.66)            |
|                                                        | 2012      | 58 (0.88)              | 1 (0.23)                        | 55 (2.18)                       | 2 (0.08)       | 0 (0.00)                 | 0 (0.00)            |
|                                                        | 2014      | 123 (1.86)             | 15 (3.07)                       | 95 (3.72)                       | 9 (0.38)       | 3 (0.45)                 | 1 (0.18)            |
|                                                        | 2016      | 186 (2.79)             | 14 (2.89)                       | 149 (5.92)                      | 16 (0.68)      | 5 (0.75)                 | 2 (0.32)            |
|                                                        | 2018      | 199 (2.98)             | 15 (3.10)                       | 160 (6.28)                      | 17 (0.72)      | 5 (0.75)                 | 2 (0.32)            |
|                                                        | 2021      | 318 (5.13)             | 20 (16.67)                      | 187 (7.76)                      | 78 (3.33)      | 2 (0.30)                 | 11 (1.69)           |
|                                                        | 2024      | 240 (3.69)             | 11 (3.71)                       | 205 (8.02)                      | 18 (0.76)      | 4 (0.60)                 | 2 (0.32)            |
| Japanese brome<br><i>Bromus japonicus</i> <sup>E</sup> | 2016      | 91 (1.37)              | 0 (0.00)                        | 8 (0.32)                        | 77 (3.27)      | 0 (0.00)                 | 6 (0.95)            |
|                                                        | 2018      | 158 (2.38)             | 0 (0.00)                        | 18 (0.71)                       | 126 (5.35)     | 0 (0.00)                 | 14 (2.23)           |
|                                                        | 2021      | 103 (1.66)             | 0 (0.00)                        | 9 (0.37)                        | 86 (3.68)      | 0 (0.00)                 | 8 (1.23)            |
|                                                        | 2024      | 32 (0.49)              | 0 (0.00)                        | 1 (0.04)                        | 30 (1.27)      | 0 (0.00)                 | 1 (0.16)            |

<sup>A</sup> Northern drainages: Only Moose Bones, Murder Hill, and South Murder Hill were completed in 2024. Millet Canyon and South Millet Canyon were not completed.

<sup>B</sup> Southern drainages: all Chicken Creek tributaries, Small Pox Creek, Matate, Sage Grouse Lek, Wasatch Saddle, Red Hill, and Fossil Butte drainages.

<sup>C</sup> Other Roads: Ruby Point, Bullpen 2-Track, Eagle Nest, and Cundick Ridge.

<sup>D</sup> Trails: Chicken Creek Nature Trail, Historic Quarry Trail.

<sup>E</sup> Added to priority list in 2016.

<sup>F</sup> Added to priority list in 2014.

<sup>G</sup> Added to priority list in 2012.

<sup>H</sup> Does not include cheatgrass, flaxweed, or Japanese brome because these species were added to the IEP priority list after the early monitoring years.

**Table 7 (continued).** Total number of patches (number per km) detected parkwide, in Northern drainages, Southern drainages, main park road, other roads, and trails in Fossil Butte National Monument, 2008–2021. Species with fewer than 5 occurrences over the sampling periods are not listed. Distances in km for different groupings: 65.08 All Park, ND = 2.97, SD = 25.565, MPR = 23.542, Road = 6.697, Trails = 6.293.

| Common Name<br>Scientific name                    | Year      | Total Patches (per km) |                                 |                                 |                |                          |                     |
|---------------------------------------------------|-----------|------------------------|---------------------------------|---------------------------------|----------------|--------------------------|---------------------|
|                                                   |           | Parkwide               | Northern Drainages <sup>A</sup> | Southern Drainages <sup>B</sup> | Main Park Road | Other Roads <sup>C</sup> | Trails <sup>D</sup> |
| Cheatgrass<br><i>Bromus tectorum</i> <sup>F</sup> | 2014      | 199 (3.01)             | 13 (2.66)                       | 31 (1.21)                       | 139 (5.92)     | 3 (0.45)                 | 13 (2.38)           |
|                                                   | 2016      | 333 (5.00)             | 11 (2.27)                       | 51 (2.02)                       | 234 (9.94)     | 7 (1.05)                 | 30 (4.77)           |
|                                                   | 2018      | 453 (6.78)             | 19 (3.92)                       | 80 (3.14)                       | 302 (12.83)    | 6 (0.90)                 | 46 (7.31)           |
|                                                   | 2021      | 312 (5.04)             | 4 (3.33)                        | 7 (0.29)                        | 262 (11.20)    | 2 (0.30)                 | 37 (5.69)           |
|                                                   | 2024      | 301 (4.63)             | 0 (0.00)                        | 11 (0.43)                       | 289 (12.28)    | 1 (0.15)                 | 6 (0.95)            |
| whitetop<br><i>Cardaria</i> sp.                   | 2008–2009 | 2 (0.03)               | 0 (0.00)                        | 0 (0.00)                        | 2 (0.11)       | 0 (0.00)                 | 0 (0.00)            |
|                                                   | 2010      | 1 (0.02)               | 0 (0.00)                        | 1 (0.04)                        | 0 (0.00)       | 0 (0.00)                 | 0 (0.00)            |
|                                                   | 2012      | 0 (0.00)               | 0 (0.00)                        | 0 (0.00)                        | 0 (0.00)       | 0 (0.00)                 | 0 (0.00)            |
|                                                   | 2014      | 1 (0.02)               | 0 (0.00)                        | 0 (0.00)                        | 1 (0.04)       | 0 (0.00)                 | 0 (0.00)            |
|                                                   | 2016      | 7 (0.11)               | 0 (0.00)                        | 3 (0.12)                        | 4 (0.17)       | 0 (0.00)                 | 0 (0.00)            |
|                                                   | 2018      | 6 (0.09)               | 4 (0.83)                        | 1 (0.04)                        | 1 (0.04)       | 0 (0.00)                 | 0 (0.00)            |
|                                                   | 2021      | 1 (0.02)               | 0 (0.00)                        | 0 (0.00)                        | 1 (0.04)       | 0 (0.00)                 | 0 (0.00)            |
|                                                   | 2024      | 2 (0.03)               | 0 (0.00)                        | 2 (0.08)                        | 0 (0.00)       | 0 (0.00)                 | 0 (0.00)            |

<sup>A</sup> Northern drainages: Only Moose Bones, Murder Hill, and South Murder Hill were completed in 2024. Millet Canyon and South Millet Canyon were not completed.

<sup>B</sup> Southern drainages: all Chicken Creek tributaries, Small Pox Creek, Matate, Sage Grouse Lek, Wasatch Saddle, Red Hill, and Fossil Butte drainages.

<sup>C</sup> Other Roads: Ruby Point, Bullpen 2-Track, Eagle Nest, and Cundick Ridge.

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<sup>E</sup> Added to priority list in 2016.

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**Table 7 (continued).** Total number of patches (number per km) detected parkwide, in Northern drainages, Southern drainages, main park road, other roads, and trails in Fossil Butte National Monument, 2008–2021. Species with fewer than 5 occurrences over the sampling periods are not listed. Distances in km for different groupings: 65.08 All Park, ND = 2.97, SD = 25.565, MPR = 23.542, Road = 6.697, Trails = 6.293.

| Common Name<br>Scientific name                | Year      | Total Patches (per km) |                                 |                                 |                |                          |                     |
|-----------------------------------------------|-----------|------------------------|---------------------------------|---------------------------------|----------------|--------------------------|---------------------|
|                                               |           | Parkwide               | Northern Drainages <sup>A</sup> | Southern Drainages <sup>B</sup> | Main Park Road | Other Roads <sup>C</sup> | Trails <sup>D</sup> |
| musk thistle<br><i>Carduus nutans</i>         | 2008–2009 | 27 (0.45)              | 8 (1.65)                        | 12 (0.47)                       | 7 (0.39)       | 0 (0.00)                 | 0 (0.00)            |
|                                               | 2010      | 37 (0.57)              | 7 (1.53)                        | 16 (0.63)                       | 13 (0.58)      | 1 (0.14)                 | 0 (0.00)            |
|                                               | 2012      | 18 (0.27)              | 5 (1.15)                        | 10 (0.40)                       | 2 (0.08)       | 0 (0.00)                 | 1 (0.17)            |
|                                               | 2014      | 30 (0.45)              | 9 (1.84)                        | 11 (0.43)                       | 9 (0.38)       | 1 (0.15)                 | 0 (0.00)            |
|                                               | 2016      | 16 (0.24)              | 4 (0.83)                        | 5 (0.20)                        | 6 (0.25)       | 0 (0.00)                 | 1 (0.16)            |
|                                               | 2018      | 12 (0.18)              | 2 (0.41)                        | 3 (0.12)                        | 6 (0.25)       | 1 (0.15)                 | 0 (0.00)            |
|                                               | 2021      | 4 (0.06)               | 2 (1.67)                        | 1 (0.04)                        | 1 (0.04)       | 0 (0.00)                 | 0 (0.00)            |
|                                               | 2024      | 19 (0.29)              | 1 (0.34)                        | 3 (0.12)                        | 15 (0.64)      | 0 (0.00)                 | 0 (0.00)            |
| spotted knapweed<br><i>Centaurea maculosa</i> | 2008–2009 | 0 (0.00)               | 0 (0.00)                        | 0 (0.00)                        | 0 (0.00)       | 0 (0.00)                 | 0 (0.00)            |
|                                               | 2010      | 1 (0.02)               | 0 (0.00)                        | 1 (0.04)                        | 0 (0.00)       | 0 (0.00)                 | 0 (0.00)            |
|                                               | 2012      | 4 (0.06)               | 0 (0.00)                        | 0 (0.00)                        | 4 (0.17)       | 0 (0.00)                 | 0 (0.00)            |
|                                               | 2014      | 6 (0.09)               | 0 (0.00)                        | 0 (0.00)                        | 6 (0.26)       | 0 (0.00)                 | 0 (0.00)            |
|                                               | 2016      | 1 (0.02)               | 0 (0.00)                        | 0 (0.00)                        | 1 (0.04)       | 0 (0.00)                 | 0 (0.00)            |

<sup>A</sup> Northern drainages: Only Moose Bones, Murder Hill, and South Murder Hill were completed in 2024. Millet Canyon and South Millet Canyon were not completed.

<sup>B</sup> Southern drainages: all Chicken Creek tributaries, Small Pox Creek, Matate, Sage Grouse Lek, Wasatch Saddle, Red Hill, and Fossil Butte drainages.

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**Table 7 (continued).** Total number of patches (number per km) detected parkwide, in Northern drainages, Southern drainages, main park road, other roads, and trails in Fossil Butte National Monument, 2008–2021. Species with fewer than 5 occurrences over the sampling periods are not listed. Distances in km for different groupings: 65.08 All Park, ND = 2.97, SD = 25.565, MPR = 23.542, Road = 6.697, Trails = 6.293.

| Common Name<br>Scientific name                            | Year      | Total Patches (per km) |                                 |                                 |                |                          |                     |
|-----------------------------------------------------------|-----------|------------------------|---------------------------------|---------------------------------|----------------|--------------------------|---------------------|
|                                                           |           | Parkwide               | Northern Drainages <sup>A</sup> | Southern Drainages <sup>B</sup> | Main Park Road | Other Roads <sup>C</sup> | Trails <sup>D</sup> |
| spotted knapweed<br><i>Centaurea maculosa</i> (continued) | 2018      | 0 (0.00)               | 0 (0.00)                        | 0 (0.00)                        | 0 (0.00)       | 0 (0.00)                 | 0 (0.00)            |
|                                                           | 2021      | 0 (0.00)               | 0 (0.00)                        | 0 (0.00)                        | 0 (0.00)       | 0 (0.00)                 | 0 (0.00)            |
|                                                           | 2024      | 0 (0.00)               | 0 (0.00)                        | 0 (0.00)                        | 0 (0.00)       | 0 (0.00)                 | 0 (0.00)            |
| Canada thistle<br><i>Cirsium arvense</i>                  | 2008–2009 | 67 (1.11)              | 10 (2.07)                       | 25 (0.98)                       | 32 (1.78)      | 0 (0.00)                 | 0 (0.00)            |
|                                                           | 2010      | 53 (0.81)              | 13 (2.85)                       | 21 (0.83)                       | 12 (0.53)      | 3 (0.43)                 | 4 (0.66)            |
|                                                           | 2012      | 9 (0.14)               | 5 (1.15)                        | 1 (0.04)                        | 2 (0.08)       | 0 (0.00)                 | 1 (0.17)            |
|                                                           | 2014      | 19 (0.29)              | 6 (1.23)                        | 11 (0.43)                       | 2 (0.09)       | 0 (0.00)                 | 0 (0.00)            |
|                                                           | 2016      | 27 (0.41)              | 9 (1.86)                        | 5 (0.20)                        | 13 (0.55)      | 0 (0.00)                 | 0 (0.00)            |
|                                                           | 2018      | 18 (0.27)              | 8 (1.65)                        | 5 (0.20)                        | 5 (0.21)       | 0 (0.00)                 | 0 (0.00)            |
|                                                           | 2021      | 27 (0.44)              | 6 (5.0)                         | 10 (0.41)                       | 10 (0.43)      | 0 (0.00)                 | 1 (0.15)            |
|                                                           | 2024      | 24 (0.37)              | 3 (1.01)                        | 11 (0.43)                       | 10 (0.42)      | 0 (0.00)                 | 0 (0.00)            |
| bull thistle<br><i>Cirsium vulgare</i>                    | 2008–2009 | 6 (0.10)               | 1 (0.21)                        | 3 (0.12)                        | 1 (0.06)       | 0 (0.00)                 | 1 (0.18)            |
|                                                           | 2010      | 9 (0.14)               | 4 (0.88)                        | 3 (0.12)                        | 1 (0.04)       | 0 (0.00)                 | 1 (0.17)            |

<sup>A</sup> Northern drainages: Only Moose Bones, Murder Hill, and South Murder Hill were completed in 2024. Millet Canyon and South Millet Canyon were not completed.

<sup>B</sup> Southern drainages: all Chicken Creek tributaries, Small Pox Creek, Matate, Sage Grouse Lek, Wasatch Saddle, Red Hill, and Fossil Butte drainages.

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**Table 7 (continued).** Total number of patches (number per km) detected parkwide, in Northern drainages, Southern drainages, main park road, other roads, and trails in Fossil Butte National Monument, 2008–2021. Species with fewer than 5 occurrences over the sampling periods are not listed. Distances in km for different groupings: 65.08 All Park, ND = 2.97, SD = 25.565, MPR = 23.542, Road = 6.697, Trails = 6.293.

| Common Name<br>Scientific name                     | Year      | Total Patches (per km) |                                 |                                 |                |                          |                     |
|----------------------------------------------------|-----------|------------------------|---------------------------------|---------------------------------|----------------|--------------------------|---------------------|
|                                                    |           | Parkwide               | Northern Drainages <sup>A</sup> | Southern Drainages <sup>B</sup> | Main Park Road | Other Roads <sup>C</sup> | Trails <sup>D</sup> |
| bull thistle<br><i>Cirsium vulgare</i> (continued) | 2012      | 6 (0.09)               | 1 (0.23)                        | 2 (0.08)                        | 3 (0.13)       | 0 (0.00)                 | 0 (0.00)            |
|                                                    | 2014      | 0 (0.00)               | 0 (0.00)                        | 0 (0.00)                        | 0 (0.00)       | 0 (0.00)                 | 0 (0.00)            |
|                                                    | 2016      | 4 (0.06)               | 0 (0.00)                        | 3 (0.12)                        | 1 (0.04)       | 0 (0.00)                 | 0 (0.00)            |
|                                                    | 2018      | 0 (0.00)               | 0 (0.00)                        | 0 (0.00)                        | 0 (0.00)       | 0 (0.00)                 | 0 (0.00)            |
|                                                    | 2021      | 0 (0.00)               | 0 (0.00)                        | 0 (0.00)                        | 0 (0.00)       | 0 (0.00)                 | 0 (0.00)            |
|                                                    | 2024      | 0 (0.00)               | 0 (0.00)                        | 0 (0.00)                        | 0 (0.00)       | 0 (0.00)                 | 0 (0.00)            |
| field bindweed<br><i>Convolvulus arvensis</i>      | 2008–2009 | 4 (0.07)               | 0 (0.00)                        | 0 (0.00)                        | 4 (0.22)       | 0 (0.00)                 | 0 (0.00)            |
|                                                    | 2010      | 1 (0.02)               | 0 (0.00)                        | 0 (0.00)                        | 1 (0.04)       | 0 (0.00)                 | 0 (0.00)            |
|                                                    | 2012      | 0 (0.00)               | 0 (0.00)                        | 0 (0.00)                        | 0 (0.00)       | 0 (0.00)                 | 0 (0.00)            |
|                                                    | 2014      | 2 (0.03)               | 0 (0.00)                        | 0 (0.00)                        | 2 (0.09)       | 0 (0.00)                 | 0 (0.00)            |
|                                                    | 2016      | 2 (0.03)               | 0 (0.00)                        | 0 (0.00)                        | 2 (0.08)       | 0 (0.00)                 | 0 (0.00)            |
|                                                    | 2018      | 2 (0.03)               | 0 (0.00)                        | 0 (0.00)                        | 2 (0.08)       | 0 (0.00)                 | 0 (0.00)            |

<sup>A</sup> Northern drainages: Only Moose Bones, Murder Hill, and South Murder Hill were completed in 2024. Millet Canyon and South Millet Canyon were not completed.

<sup>B</sup> Southern drainages: all Chicken Creek tributaries, Small Pox Creek, Matate, Sage Grouse Lek, Wasatch Saddle, Red Hill, and Fossil Butte drainages.

<sup>C</sup> Other Roads: Ruby Point, Bullpen 2-Track, Eagle Nest, and Cundick Ridge.

<sup>D</sup> Trails: Chicken Creek Nature Trail, Historic Quarry Trail.

<sup>E</sup> Added to priority list in 2016.

<sup>F</sup> Added to priority list in 2014.

<sup>G</sup> Added to priority list in 2012.

<sup>H</sup> Does not include cheatgrass, flaxweed, or Japanese brome because these species were added to the IEP priority list after the early monitoring years.

**Table 7 (continued).** Total number of patches (number per km) detected parkwide, in Northern drainages, Southern drainages, main park road, other roads, and trails in Fossil Butte National Monument, 2008–2021. Species with fewer than 5 occurrences over the sampling periods are not listed. Distances in km for different groupings: 65.08 All Park, ND = 2.97, SD = 25.565, MPR = 23.542, Road = 6.697, Trails = 6.293.

| Common Name<br>Scientific name                            | Year      | Total Patches (per km) |                                 |                                 |                |                          |                     |
|-----------------------------------------------------------|-----------|------------------------|---------------------------------|---------------------------------|----------------|--------------------------|---------------------|
|                                                           |           | Parkwide               | Northern Drainages <sup>A</sup> | Southern Drainages <sup>B</sup> | Main Park Road | Other Roads <sup>C</sup> | Trails <sup>D</sup> |
| field bindweed<br><i>Convolvulus arvensis</i> (continued) | 2021      | 3 (0.05)               | 0 (0.00)                        | 0 (0.00)                        | 3 (0.13)       | 0 (0.00)                 | 0 (0.00)            |
|                                                           | 2024      | 1 (0.02)               | 0 (0.00)                        | 0 (0.00)                        | 1 (0.04)       | 0 (0.00)                 | 0 (0.00)            |
| Flixweed<br><i>Descurainia sophia</i> <sup>G</sup>        | 2012      | 3 (0.05)               | 0 (0.00)                        | 1 (0.04)                        | 2 (0.08)       | 0 (0.00)                 | 0 (0.00)            |
|                                                           | 2014      | 164 (2.48)             | 6 (1.23)                        | 64 (2.51)                       | 75 (3.19)      | 9 (1.35)                 | 10 (1.83)           |
|                                                           | 2016      | 80 (1.20)              | 3 (0.62)                        | 23 (0.91)                       | 43 (1.83)      | 0 (0.00)                 | 11 (1.75)           |
|                                                           | 2018      | 55 (0.82)              | 6 (1.24)                        | 6 (0.24)                        | 33 (1.40)      | 3 (0.45)                 | 7 (1.11)            |
|                                                           | 2021      | 36 (0.58)              | 0 (0.00)                        | 5 (0.25)                        | 26 (1.11)      | 2 (0.30)                 | 3 (0.46)            |
|                                                           | 2024      | 33 (0.51)              | 0 (0.00)                        | 3 (0.12)                        | 30 (1.27)      | 0 (0.00)                 | 0 (0.00)            |
| quackgrass<br><i>Elymus repens</i>                        | 2008–2009 | 53 (0.88)              | 0 (0.00)                        | 3 (0.12)                        | 49 (2.73)      | 1 (0.15)                 | 0 (0.00)            |
|                                                           | 2010      | 95 (1.45)              | 13 (2.85)                       | 0 (0.00)                        | 69 (3.06)      | 8 (1.15)                 | 5 (0.83)            |
|                                                           | 2012      | 23 (0.35)              | 0 (0.00)                        | 2 (0.08)                        | 21 (0.89)      | 0 (0.00)                 | 0 (0.00)            |
|                                                           | 2014      | 5 (0.35)               | 1 (0.20)                        | 0 (0.00)                        | 4 (0.17)       | 0 (0.00)                 | 0 (0.00)            |
|                                                           | 2016      | 31 (0.47)              | 0 (0.00)                        | 2 (0.08)                        | 25 (1.06)      | 0 (0.00)                 | 4 (0.64)            |

<sup>A</sup> Northern drainages: Only Moose Bones, Murder Hill, and South Murder Hill were completed in 2024. Millet Canyon and South Millet Canyon were not completed.

<sup>B</sup> Southern drainages: all Chicken Creek tributaries, Small Pox Creek, Matate, Sage Grouse Lek, Wasatch Saddle, Red Hill, and Fossil Butte drainages.

<sup>C</sup> Other Roads: Ruby Point, Bullpen 2-Track, Eagle Nest, and Cundick Ridge.

<sup>D</sup> Trails: Chicken Creek Nature Trail, Historic Quarry Trail.

<sup>E</sup> Added to priority list in 2016.

<sup>F</sup> Added to priority list in 2014.

<sup>G</sup> Added to priority list in 2012.

<sup>H</sup> Does not include cheatgrass, flixweed, or Japanese brome because these species were added to the IEP priority list after the early monitoring years.

**Table 7 (continued).** Total number of patches (number per km) detected parkwide, in Northern drainages, Southern drainages, main park road, other roads, and trails in Fossil Butte National Monument, 2008–2021. Species with fewer than 5 occurrences over the sampling periods are not listed. Distances in km for different groupings: 65.08 All Park, ND = 2.97, SD = 25.565, MPR = 23.542, Road = 6.697, Trails = 6.293.

| Common Name<br>Scientific name                      | Year      | Total Patches (per km) |                                 |                                 |                |                          |                     |
|-----------------------------------------------------|-----------|------------------------|---------------------------------|---------------------------------|----------------|--------------------------|---------------------|
|                                                     |           | Parkwide               | Northern Drainages <sup>A</sup> | Southern Drainages <sup>B</sup> | Main Park Road | Other Roads <sup>C</sup> | Trails <sup>D</sup> |
| quackgrass<br><i>Elymus repens</i> (continued)      | 2018      | 20 (0.30)              | 0 (0.00)                        | 1 (0.04)                        | 19 (0.81)      | 0 (0.00)                 | 0 (0.00)            |
|                                                     | 2021      | 5 (0.08)               | 0 (0.00)                        | 0 (0.00)                        | 5 (0.21)       | 0 (0.00)                 | 0 (0.00)            |
|                                                     | 2024      | 73 (1.12)              | 0 (0.00)                        | 0 (0.00)                        | 71 (3.02)      | 2 (0.30)                 | 0 (0.00)            |
| black henbane<br><i>Hyoscyamus niger</i>            | 2008–2009 | 19 (0.31)              | 1 (0.21)                        | 2 (0.08)                        | 16 (0.89)      | 0 (0.00)                 | 0 (0.00)            |
|                                                     | 2010      | 5 (0.08)               | 1 (0.22)                        | 2 (0.08)                        | 2 (0.09)       | 0 (0.00)                 | 0 (0.00)            |
|                                                     | 2012      | 4 (0.06)               | 0 (0.00)                        | 0 (0.00)                        | 4 (0.17)       | 0 (0.00)                 | 0 (0.00)            |
|                                                     | 2014      | 4 (0.06)               | 0 (0.00)                        | 0 (0.00)                        | 4 (0.17)       | 0 (0.00)                 | 0 (0.00)            |
|                                                     | 2016      | 10 (0.15)              | 0 (0.00)                        | 0 (0.00)                        | 10 (0.42)      | 0 (0.00)                 | 0 (0.00)            |
|                                                     | 2018      | 3 (0.04)               | 0 (0.00)                        | 0 (0.00)                        | 3 (0.13)       | 0 (0.00)                 | 0 (0.00)            |
|                                                     | 2021      | 9 (0.15)               | 0 (0.00)                        | 0 (0.00)                        | 9 (0.38)       | 0 (0.00)                 | 0 (0.00)            |
|                                                     | 2024      | 20 (0.31)              | 0 (0.00)                        | 0 (0.00)                        | 20             | 0 (0.00)                 | 0 (0.00)            |
| yellow sweet-clover<br><i>Melilotus officinalis</i> | 2008–2009 | 54 (0.89)              | 0 (0.00)                        | 6 (0.24)                        | 48 (2.67)      | 0 (0.00)                 | 0 (0.00)            |
|                                                     | 2010      | 54 (0.83)              | 0 (0.00)                        | 18 (0.71)                       | 35 (1.55)      | 0 (0.00)                 | 1 (0.17)            |

<sup>A</sup> Northern drainages: Only Moose Bones, Murder Hill, and South Murder Hill were completed in 2024. Millet Canyon and South Millet Canyon were not completed.

<sup>B</sup> Southern drainages: all Chicken Creek tributaries, Small Pox Creek, Matate, Sage Grouse Lek, Wasatch Saddle, Red Hill, and Fossil Butte drainages.

<sup>C</sup> Other Roads: Ruby Point, Bullpen 2-Track, Eagle Nest, and Cundick Ridge.

<sup>D</sup> Trails: Chicken Creek Nature Trail, Historic Quarry Trail.

<sup>E</sup> Added to priority list in 2016.

<sup>F</sup> Added to priority list in 2014.

<sup>G</sup> Added to priority list in 2012.

<sup>H</sup> Does not include cheatgrass, flxweed, or Japanese brome because these species were added to the IEP priority list after the early monitoring years.

**Table 7 (continued).** Total number of patches (number per km) detected parkwide, in Northern drainages, Southern drainages, main park road, other roads, and trails in Fossil Butte National Monument, 2008–2021. Species with fewer than 5 occurrences over the sampling periods are not listed. Distances in km for different groupings: 65.08 All Park, ND = 2.97, SD = 25.565, MPR = 23.542, Road = 6.697, Trails = 6.293.

| Common Name<br>Scientific name                                  | Year      | Total Patches (per km) |                                 |                                 |                |                          |                     |
|-----------------------------------------------------------------|-----------|------------------------|---------------------------------|---------------------------------|----------------|--------------------------|---------------------|
|                                                                 |           | Parkwide               | Northern Drainages <sup>A</sup> | Southern Drainages <sup>B</sup> | Main Park Road | Other Roads <sup>C</sup> | Trails <sup>D</sup> |
| yellow sweet-clover<br><i>Melilotus officinalis</i> (continued) | 2012      | 10 (0.15)              | 0 (0.00)                        | 3 (0.12)                        | 6 (0.25)       | 0 (0.00)                 | 1 (0.17)            |
|                                                                 | 2014      | 20 (0.30)              | 0 (0.00)                        | 5 (0.20)                        | 15 (0.64)      | 0 (0.00)                 | 0 (0.00)            |
|                                                                 | 2016      | 23 (0.35)              | 0 (0.00)                        | 8 (0.32)                        | 14 (0.59)      | 0 (0.00)                 | 1 (0.16)            |
|                                                                 | 2018      | 21 (0.31)              | 0 (0.00)                        | 11 (0.43)                       | 6 (0.25)       | 0 (0.00)                 | 4 (0.64)            |
|                                                                 | 2021      | 32 (0.52)              | 0 (0.00)                        | 9 (0.37)                        | 19 (0.81)      | 0 (0.00)                 | 4 (0.62)            |
|                                                                 | 2024      | 55 (0.85)              | 0 (0.00)                        | 16 (0.63)                       | 32 (0.85)      | 0 (0.00)                 | 7 (1.11)            |
| All IEP species <sup>H</sup>                                    | 2008–2009 | 256 (4.24)             | 22 (4.54)                       | 73 (2.87)                       | 159 (8.85)     | 1 (0.15)                 | 1 (0.18)            |
|                                                                 | 2010      | 319 (4.88)             | 46 (10.08)                      | 105 (4.16)                      | 139 (6.17)     | 14 (2.01)                | 15 (2.49)           |
|                                                                 | 2012      | 132 (2.00)             | 12 (2.77)                       | 73 (2.89)                       | 44 (1.87)      | 0 (0.00)                 | 3 (0.50)            |
|                                                                 | 2014      | 210 (3.18)             | 31 (6.35)                       | 122 (4.78)                      | 52 (2.21)      | 4 (0.60)                 | 1 (0.18)            |
|                                                                 | 2016      | 307 (4.61)             | 27 (5.58)                       | 175 (6.95)                      | 92 (3.91)      | 5 (0.75)                 | 8 (1.27)            |
|                                                                 | 2018      | 281 (4.21)             | 29 (5.99)                       | 181 (7.11)                      | 59 (2.51)      | 6 (0.90)                 | 6 (0.95)            |
|                                                                 | 2021      | 318 (5.14)             | 20 (16.67)                      | 207 (8.59)                      | 78 (3.33)      | 2 (0.30)                 | 11 (1.69)           |

<sup>A</sup> Northern drainages: Only Moose Bones, Murder Hill, and South Murder Hill were completed in 2024. Millet Canyon and South Millet Canyon were not completed.

<sup>B</sup> Southern drainages: all Chicken Creek tributaries, Small Pox Creek, Matate, Sage Grouse Lek, Wasatch Saddle, Red Hill, and Fossil Butte drainages.

<sup>C</sup> Other Roads: Ruby Point, Bullpen 2-Track, Eagle Nest, and Cundick Ridge.

<sup>D</sup> Trails: Chicken Creek Nature Trail, Historic Quarry Trail.

<sup>E</sup> Added to priority list in 2016.

<sup>F</sup> Added to priority list in 2014.

<sup>G</sup> Added to priority list in 2012.

<sup>H</sup> Does not include cheatgrass, flaxweed, or Japanese brome because these species were added to the IEP priority list after the early monitoring years.

**Table 7 (continued).** Total number of patches (number per km) detected parkwide, in Northern drainages, Southern drainages, main park road, other roads, and trails in Fossil Butte National Monument, 2008–2021. Species with fewer than 5 occurrences over the sampling periods are not listed. Distances in km for different groupings: 65.08 All Park, ND = 2.97, SD = 25.565, MPR = 23.542, Road = 6.697, Trails = 6.293.

| Common Name<br><i>Scientific name</i>    | Year | Total Patches (per km) |                                 |                                 |                |                          |                     |
|------------------------------------------|------|------------------------|---------------------------------|---------------------------------|----------------|--------------------------|---------------------|
|                                          |      | Parkwide               | Northern Drainages <sup>A</sup> | Southern Drainages <sup>B</sup> | Main Park Road | Other Roads <sup>C</sup> | Trails <sup>D</sup> |
| All IEP species <sup>H</sup> (continued) | 2024 | 438 (6.73)             | 15 (5.05)                       | 237 (9.27)                      | 171 (7.26)     | 6 (0.90)                 | 9 (1.43)            |

<sup>A</sup> Northern drainages: Only Moose Bones, Murder Hill, and South Murder Hill were completed in 2024. Millet Canyon and South Millet Canyon were not completed.

<sup>B</sup> Southern drainages: all Chicken Creek tributaries, Small Pox Creek, Matate, Sage Grouse Lek, Wasatch Saddle, Red Hill, and Fossil Butte drainages.

<sup>C</sup> Other Roads: Ruby Point, Bullpen 2-Track, Eagle Nest, and Cundick Ridge.

<sup>D</sup> Trails: Chicken Creek Nature Trail, Historic Quarry Trail.

<sup>E</sup> Added to priority list in 2016.

<sup>F</sup> Added to priority list in 2014.

<sup>G</sup> Added to priority list in 2012.

<sup>H</sup> Does not include cheatgrass, flaxweed, or Japanese brome because these species were added to the IEP priority list after the early monitoring years.

Cheatgrass increased in patches per kilometer since it was added to the IEP priority list in 2014 (from 3.01 patches/km in 2014 to 6.96 patches/km in 2018) but then declined to 5.04 patches/km in 2021 and again in 2024 to 4.63 patches /km (see Table 7). Cheatgrass along the Main Park Road increased steadily from 5.92 patches/km in 2014 to 12.28 patches/km in 2024. However, cheatgrass decreased along park trails, northern drainages, and southern drainages.

The number of patches per kilometer of creeping foxtail has varied over time. The number of infestations in 2024 (3.69 patches/km) is lower than 2021 (5.13 patches/km), but it was still the second highest number of infestations per km over the eight sample periods (see Table 7). Perkins (2011) noted that observers had difficulty identifying this plant in 2008 and 2010 because of misidentification, so early numbers from those years are suspect.

Other notable declines or absences in 2024 included:

- Japanese brome increased from 1.37 patches/km in 2016 (when it was added to the IEP priority list) to 2.39 patches/km in 2018, but then declined to 1.66 patches/km in 2021 and declined to 0.49 patches/km in 2024.
- Flixweed (*Descurainia sophia*) continued to decline, with 0.51 patches/km in 2024 down from a high of 2.48 patches/km in 2014.
- Quackgrass increased to 1.12 patches/km in 2024, up from 0.08 patches/km in 2021. The 2024 level was the second-highest number of patches/km observed, exceeded only by 1.45 patches/km in 2010 (Table 7).
- Black henbane (*Hyoscyamus niger*) increased to 0.84 patches/km in 2024, up from 0.52 patches in 2021. The 2024 level was the second-highest infestation rate in the eight sample periods.
- Yellow sweet-clover increased to 0.31 patches/ km in 2024, up from 0.15 patches in 2021. The 2024 level matched the highest infestation rate that was found in 2008–09.
- Spotted knapweed (*Centaurea maculosa*) and bull thistle (*Cirsium vulgare*) were not found. Neither species has been detected since 2016.

To examine IEP species over time in different areas of Fossil Butte NM, we combined routes into five areas:

- Northern drainages: Murder Hill, Millet Canyon, South Millet Canyon, South Murder Hill, and Moose Bones Canyon (only Moose Bones, Murder Hill, and South Murder Hill were completed in 2024);
- Southern drainages: Smallpox, Matate, West Red Hill, East Red Hill, Fossil Butte East, Fossil Butte Northwest, Fossil Butte Middle, Wasatch Saddle, Sage Grouse Lek, Northeast Fork of Chicken Creek, East Fork of Chicken Creek, West Fork of Chicken Creek, North Dam Fork of Chicken Creek, and Chicken Creek;
- Main Park Road: Main Park Road;

- Other roads: Eagle Nest Point, Ruby Point, Bullpen Two Track, and Cundick Ridge; and
- Trails: Chicken Creek and Historic Quarry.

We compared patch density of all IEP priority species in the five areas over time, excluding cheatgrass, Japanese brome, and flixweed, which were added to the list after the early monitoring years. Southern drainages showed increases in overall IEP patch densities over all monitoring years, from 2.87 patches/km in 2008–2009 to 8.59 patches/km in 2021 and 9.27 patches/km in 2024 (see Table 6). This increase was driven mostly by an increase in creeping foxtail.

After declining over earlier sample periods, patch density on the Main Park Road increased from 2014 (4.78 patches/km) to 2024 (9.27 patches/km), with this increase driven by quackgrass, black henbane, yellow sweet-clover, and musk thistle (*Carduus nutans*) from 2021 to 2024. Previously, creeping foxtail was driving the increase, but this species declined dramatically in 2024 when compared with 2021.

Rates of infestations/km have remained low along roads other than the Main Park Road and along trails. Musk thistle, bull thistle, and Canada thistle (*Cirsium arvense*) have all had general declines in the Northern drainages.

Only IEP priority species and cheatgrass have been reliably recorded on transects across all study years. Percent cover of all priority IEPs has been low over time. Estimated percent cover of cheatgrass along the Main Park Road have fluctuated below 1% (range 0.1–0.9%) across all monitoring years. From 2008–2009 to 2021, the percentage of transects containing cheatgrass parkwide rose from 2.9% to 27.2% in 2018, then declining to 16.3% in 2021 before increasing to 45.7% in 2024.

## 4 Discussion

The NCPN will continue to work with park staff and area IEP experts to review and update the list of priority species annually. Presence–absence data for priority IEP species should be reliable for the area surveyed. The NCPN has no recommendations to add to the priority IEP list for future years.

### 4.1 Park Control Efforts and Species Response

In 2022, Fossil Butte staff treated 15 IEP species, including 13 priority species. Efforts resulted in 52 33-gallon bags of mowed cheatgrass, Japanese brome, and yellow sweet-clover. Yellow sweet-clover mowing was an attempt to reduce seed production in a dense population near the Historic Quarry Trail. Non-rhizomatous plants pulled totaled 23,688, and an additional 4.5 acres were sprayed to control rhizomatous plants.

In 2023, Fossil Butte staff treated 19 IEP species, including 15 priority species. Efforts resulted in 35 33-gallon bags of mowed cheatgrass with a minor component of Japanese brome. Yellow sweet-clover was not mowed, but 1,676 additional plants were pulled. Non-rhizomatous plants pulled totaled 34,820, and an additional 96.4 acres were sprayed to control rhizomatous plants. The sudden increase in acres sprayed marks the beginning of our efforts to control smooth brome and creeping foxtail.

In 2024, Fossil Butte staff treated 20 IEP species, including 17 priority species. Efforts resulted in 7.5 33-gallon bags of mowed cheatgrass with a minor component of Japanese brome. Yellow sweet-clover was not mowed, but the dense concentration near the Historic Quarry Trail was sprayed with Milestone before it bloomed. Non-rhizomatous plants pulled totaled 88,232, and an additional 22.3 acres were sprayed to control rhizomatous plants. Spraying included retreating resprouts of smooth brome and extending spraying to patches not treated in 2023.

Cheatgrass has stayed stable parkwide, but despite control efforts, cheatgrass increased in 2024 along the Main Park Road, more than doubling since 2014 from 5.92 patches/km in 2014 to 12.28 patches/km in 2024. This species is extremely difficult to control, and Fossil Butte is one of the few parks that has been able to keep it somewhat in check. Park records show that cheatgrass declined in bags mowed over the same area, indicating that mechanical control was having the desired result. After mowing in 2024, Rejuvra was applied to infested roadside areas. This is the first use of the germination inhibitor at Fossil Butte NM. If it is effective, the park plans to treat additional areas in 2025. Japanese brome, another target of control efforts, decreased dramatically in 2024 to just 0.49 patches/km, down from 1.66 and 2.39 patches/km in 2021 and 2018, respectively. These two annual brome species are known to fluctuate based on annual precipitation.

Park staff's intensive focus on yellow sweet-clover has likely kept this species stable, without these efforts, this species would likely have increased dramatically.

Park records show flixweed saw a 50% decline in plants pulled from 2022 to 2023, then held steady at 3,000 plants pulled in 2023 and 2024, while this report indicates a relatively stable number of

infestations per kilometer from 2021 to 2024. Taken together, this could indicate that the species presence is declining in the park.

Control efforts have faced some obstacles, and control techniques continue to evolve as staff learn from experience. Park staff have found it is better to pull and count the non-rhizomatous common hound's tongue (*Cynoglossum officinale*) and spotted knapweed. Spotted knapweed has a widespread morphology with small leaves, so there can be collateral damage to native species when sprayed. It is also easiest to detect when in bloom. If sprayed while in bloom, this species can still set viable seeds. In 2025, park staff pulled spotted knapweed a week after the Invasive Plant Management Team sprayed. Many were in bloom when pulled, and at the time of this writing, park staff have pulled over 300 plants, showing a marked increase in plant abundance over previous years. The number of plants pulled and acres treated varies from year to year. This may be attributed to the experience of the seasonal biological technicians. Based on the continued expansion of creeping foxtail noted in these reports, the park will increase efforts to control this species.

#### **4.2 Additional Invasive Plant Observations**

Overall, across the park, priority invasive plant patches have slowly increased over time, with 6.67 patches/km detected in 2024 compared with 4.24 patches/km in the first sample in 2008–2009.

Common hound's tongue, woolly mullein, and field sowthistle were detected along our monitoring routes for the first time, despite being on the priority list since monitoring began in 2008.

Areas away from riparian routes and the Main Park Road continued to have fewer priority IEPs. However, in 2024, only the Eagle Nest Point Road had no invasive patches detected, compared with 2021, when the Wasatch Saddle drainage, North Dam Fork of Chicken Creek, and Fossil Butte Northwest drainage were free of priority weed species. Efforts should be made to eliminate patches in nearby drainages and trails to prevent increases in these areas.

It should be noted that estimates of percent cover in this report (see Table 5) are limited to routes that were surveyed. Actual percent cover of IEPs across the entire park cannot be determined with these methods. Because monitoring focuses on areas most likely to be invaded by a broad suite of IEPs, it is plausible that the percent cover for most IEP species is lower in the park interior than along the monitoring routes.

The monitoring crew also noted that the following non-priority exotic species were found across the park:

- High amounts of: common dandelion (*Taraxacum officinale*), little bur-clover (*Medicago minima*), Kentucky bluegrass (*Poa pratensis*), and smooth brome (*Bromus inermis*).
- Moderate amounts of: bulbous bluegrass (*Poa bulbosa*) and desert madwort (*Alyssum desertorum*).
- Sparse amounts of: African mustard (*Malcolmia africana*), bigbract verbena (*Verbena bracteata*), clasping pepperweed (*Lepidium perfoliatum*), creeping bentgrass (*Agrostis*

*stolonifera*), crested wheatgrass (*Agropyron cristatum*), curly dock (*Rumex crispus*), curvseed butterwort (*Ceratocephala testiculata*), field pennycress (*Thlaspi arvense*), prickly lettuce (*Lactuca serriola*), prostrate knotweed (*Polygonum aviculare*), redstem stork's bill (*Erodium cicutarium*), and yellow salsify (*Tragopogon dubius*).

The NCPN will continue to work with Fossil Butte NM staff to review and update the list of priority species each year. Based on current control efforts, yellow salsify could be considered for addition to the park's IEP priority list. Presence and absence data for most priority species are reliable for the areas searched. However, absence data for other species are suspect and less reliable because they are not consistently recorded from year to year.

Priority IEPs at Fossil Butte NM will generally be monitored at the same time of year in future monitoring efforts. Consistency in 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 substantially 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

- 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.
- Executive Order 13112. 1999. Invasive species. Federal register 64, no. 25 (February 8, 1999): 6183–86.
- Maxwell, S.L., R.A. Fuller, T.M. Brooks, and J.E.M. Watson. 2016. The ravages of guns, nets and bulldozers. *Nature* 536:143–145.
- Mooney, H., and R.J. Hobbs, editors. 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 Research Council (NRC). 2002. Predicting invasions of nonindigenous plants and plant pests. National Academy of Sciences, Washington, D.C.
- Northern Colorado Plateau Network (NCPN). 2025a. Exotic plant patches detected on monitoring routes Fossil Butte National Monument, 2024 [dataset]. National Park Service, Fort Collins, Colorado. <https://irma.nps.gov/DataStore/Reference/Profile/2315133>
- Northern Colorado Plateau Network (NCPN). 2025b. Exotic plant transect data detected at Fossil Butte National Monument, 2024 [dataset]. National Park Service, Fort Collins, Colorado. <https://irma.nps.gov/DataStore/Reference/Profile/2315132>
- 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. <https://irma.nps.gov/DataStore/Reference/Profile/579097>
- Perkins, D.W. 2010. Invasive exotic plant monitoring at Fossil Butte National Monument, annual report 2009. Natural Resource Technical Report NPS/NCPN/NRTR—2010/322. National Park Service, Fort Collins, Colorado. <https://irma.nps.gov/DataStore/Reference/Profile/664685>
- Perkins, D.W. 2011. Invasive exotic plant monitoring at Fossil Butte National Monument: 2010 field season. Natural Resource Technical Report NPS/NCPN/NRTR—2011/466. National Park Service, Fort Collins, Colorado. <https://irma.nps.gov/DataStore/Reference/Profile/2172116>

- Perkins, D.W. 2013. Invasive exotic plant monitoring in Fossil Butte National Monument: Field seasons 2008–2012. Natural Resource Technical Report NPS/NCPN/NRTR—2013/751. National Park Service, Fort Collins, Colorado.  
<https://irma.nps.gov/DataStore/Reference/Profile/2195338>
- Perkins, D.W. 2015. Invasive exotic plant monitoring at Fossil Butte National Monument: 2014 field season. Natural Resource Report NPS/NCPN/NRR—2015/988. National Park Service, Fort Collins, Colorado. <https://irma.nps.gov/DataStore/Reference/Profile/2222971>
- Perkins, D.W. 2017. Invasive exotic plant monitoring at Fossil Butte National Monument: 2016 field season. Natural Resource Report NPS/NCPN/NRR—2017/1555. National Park Service, Fort Collins, Colorado. <https://irma.nps.gov/DataStore/Reference/Profile/2247634>
- Perkins, D.W. 2022. Invasive exotic plant monitoring at Fossil Butte National Monument: 2021 field season. Natural Resource Report NPS/NCPN/NRR—2022/2451. National Park Service, Fort Collins, Colorado. <https://doi.org/10.36967/2288496>
- Perkins, D.W., and R. Weissinger. 2009. Invasive exotic plant monitoring at Fossil Butte National Monument, 2008 pilot field season. Natural Resource Technical Report NPS/NCPN/NRTR—2009/234. National Park Service, Fort Collins, Colorado.  
<https://irma.nps.gov/DataStore/Reference/Profile/662293>
- 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. Natural Resource Report NPS/NCPN/NRR—2016/1340. National Park Service, Fort Collins, Colorado. <https://irma.nps.gov/DataStore/Reference/Profile/2236996>
- Washuta, A., and D.W. Perkins. 2019. Invasive exotic plant monitoring at Fossil Butte National Monument: 2018 field season. Natural Resource Report NPS/NCPN/NRR—2019/1920. National Park Service, Fort Collins, Colorado. <https://irma.nps.gov/DataStore/Reference/Profile/2260329>



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