



Invasive Exotic Plant Monitoring at Fossil Butte National Monument

2010 Field Season

Natural Resource Technical Report NPS/NCPN/NRTR—2011/466



ON THE COVER

Fossil Butte National Monument. NPS photo.

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Abstract

Invasive exotic plant (IEP) species are one of the biggest threats to natural ecosystem integrity and biodiversity, and controlling them is a high priority for the National Park Service. The Northern Colorado Plateau Network (NCPN) selected the early detection of IEPs as one of 10 monitoring protocols to be implemented as part of its long-term monitoring program. This report represents work completed during 2010 at Fossil Butte National Monument (FOBU) and compares 2010 data to surveys conducted in 2008 and 2009. We detected 21 IEP species on monitoring routes and quadrats in 2010 at FOBU. Of these, 11 were Priority 1 species for the park that were consistently recorded in each year. Some IEPs that were targeted for control along the Main Park Road and Chicken Creek were found in reduced numbers in 2010, when compared to previous years. However, Priority 1 IEPs have increased in number and size of infestations in most other areas, as detected on monitoring routes and transects. No new Priority 1 species were detected along monitoring routes in 2010. Generally, the further a route was from areas of high visitation, the fewer IEPs were detected on it. Many IEPs are present in small, localized invasions that have a promising chance of successful management control and eradication. NCPN staff will return to FOBU to re-visit all monitoring routes in 2012.

Acronyms

BFP	between feature position
EDD	effective detection distance
EDSW	effective detection swath width
FOBU	Fossil Butte National Monument
GPS	global positioning system
IEP	invasive exotic plants
MDTS	minimum detection target size
NCPN	Northern Colorado Plateau Network
NPS	National Park Service
PSR	patch separation resolution

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1 Introduction

Invasive exotic species fragment native ecosystems, displace native plants and animals, and alter ecosystem function. Invasive species are second only to habitat loss as threats to global biodiversity (Scott and Wilcove 1998) and represent one of the most serious threats to natural ecosystem integrity (National Research Council 2002). 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, national parks of the Northern Colorado Plateau Network (NCPN) identified invasive exotic plants (IEPs) as a high-priority vital sign for long-term monitoring (O'Dell et al. 2005).

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

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

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 is focusing on the most likely areas where a broad range of invasive exotic plants may occur: riparian corridors, roads, trails, areas of high visitor impact (e.g., campgrounds), and park boundaries. This approach is cost-effective for finding many new invasions in areas where they are most likely to occur, but it may miss exotic plants dispersed to the interior areas of large parks by wind and/or animals.

Specific objectives of NCPN invasive exotic plant monitoring are:

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

This report summarizes the 2010 field season at Fossil Butte National Monument (FOBU) and makes comparisons to data collected in 2008 and 2009 (Perkins and Weissinger 2009; Perkins 2010). All roads, trails, and major drainages have been surveyed at least twice.

2 Methods

We followed the invasive exotic plant monitoring protocol developed by the NCPN (in review), adapted from Andersen and Dewey (2007). The protocol emphasizes the quick collection of IEP location and abundance data in order to maximize the amount of 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). We establish a series of co-located monitoring routes and quadrats along all roads, major drainages, and trails in the park. The quadrats, which are sampled in a quantitative manner, are used to make inference to 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, with the goal of maximizing our opportunities for detecting IEPs in the park.

2.1 Developing a park target invasive exotic plant list

Prior to beginning monitoring in 2010, NCPN and FOBU staff reviewed the list of high-priority target IEPs for FOBU (see Appendix A) that was initially developed in 2008. The original list was developed by reviewing past park literature and state and county weed lists, and consulting with park staff and county weed managers. Our high-priority target IEP list includes existing IEPs and potential IEPs of high management concern. Because these methods are designed to be rapid, field crews are trained to develop a focused search image on the target plants instead of looking for every possible invasive plant species. The likelihood of eradicating these target species, or containing them within a park, is generally high. The list of Priority 1 species is reviewed before each field season. There were no changes to the Priority 1 List from 2008 to 2010. FOBU staff recommended that flaxweed (*Descurainia sophia*) be added to the Priority 1 list in 2010, but it was inadvertently left off. It will be added to the Priority 1 list for future monitoring.

2.2 Monitoring routes

2.2.1 Minimum detection target size

The minimum detection target size (MDTS) represents the patch size that is large enough to be detected 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 so that any missed patches smaller than the MDTS could still feasibly be eradicated if not found until the next scheduled monitoring visit. We establish an MDTS of 40 m² (0.01 acres or approximately 20 × 20 ft) for all IEPs. Use of the MDTS is necessary because field technicians are not expected to find every single plant of every targeted weed species during route surveys. Although searching for single mature plants of some species, such as Russian olive (*Elaeagnus angustifolia*) and tamarisk (*Tamarix* spp.), is possible due to their large size, single plants of other species, such as field bindweed (*Convolvulus arvensis*), are nearly impossible to detect in most field conditions.

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 targeted species with at least 90% detection efficiency. Using fake plants of a targeted size, crew members are trained by walking away and determining the maximum distance from which they can consistently see and recognize the patch with complete confidence. The size of the EDD is then estimated in the field by crew members. The distance is measured either by pacing or using a laser rangefinder. The EDD for FOBU in 2010 was between 5 and 50 m, depending on vegetation.

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 target species of the MDTS (Figure 2-1). The effective detection swath width (EDSW) is equal to two times the EDD, because the surveyor is able to effectively detect weeds for one EDD on either side of his/her search route. The EDSW ranged from 10 to 100 m at FOBU in 2010.

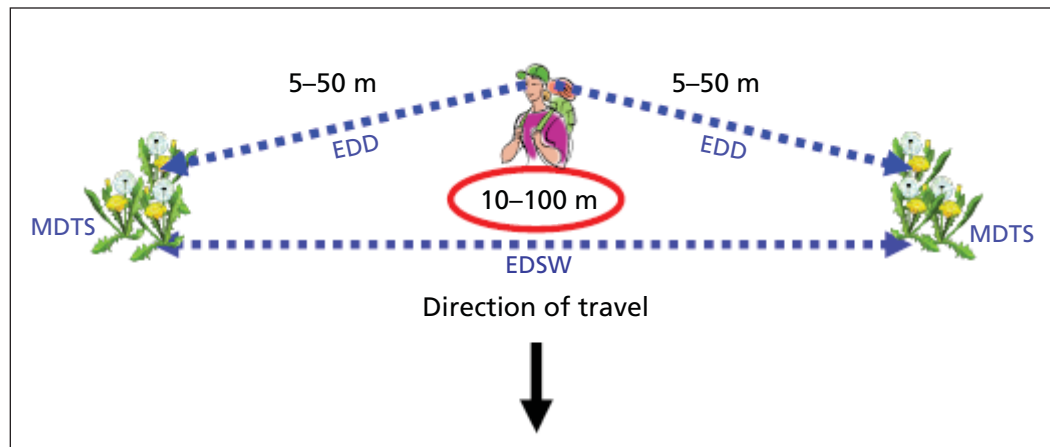


Figure 2-1. The maximum effective detection distance (EDD) at Fossil Butte NM ranged from 5 to 50 meters, making the effective detection swath width (EDSW) 10–100 meters.

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 patches or infestations. Individuals or clusters of a target species separated by the PSR distance or more were recorded as separate patches. We consider plants separated by less than the PSR to be a single patch or infestation. 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 to be one infestation during planning and implementation of weed-control operations. If an infestation is continuous for more than 50 m, cover estimates were made every 50 m to aid in developing an effective management strategy for the entire infestation.

2.2.5 Between feature position

Between Feature Positions (BFPs) allow electronic tracking of a user's route. GPS units are set to automatically generate these positions at a distance equal to the EDSW. Each time a surveyor walks the equivalent of one EDSW, the GPS unit creates a point.

2.2.6 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 (Figure 2-2).

While walking, we searched for IEPs by visually scanning (side-to-side) all of the land within the borders of the swath. However, if the terrain was uneven or steep, and the observer had to glance frequently at the ground to ensure safe foot placement, then searchers stopped approximately every 10–100 m (the length of one EDSW) and visually scanned the area in all directions. As we traversed monitoring routes, we documented locations of all target species using global positioning system (GPS) units with at least five-meter accuracy.

Only species designated as Priority 1 were consistently recorded on monitoring routes, with the exception of cheatgrass (*Bromus tectorum*), which park staff requested we map along the Main Park Road. Survey crew members were permitted to record additional species if they were noteworthy.

When a Priority 1 IEP was discovered, we recorded the following information: (1) the monitoring route, (2) the sequential number of the invasion per monitoring route, (3) infestation size class (see below), (4) whether the plant was pulled, and (5) canopy cover class (see below). If several species were present with similar distributions at a single point, we recorded a point for each individual species and assigned it its own sequential identification number. Invasions more than 50 m (55 yards) apart were considered separate invasions and recorded with separate points.

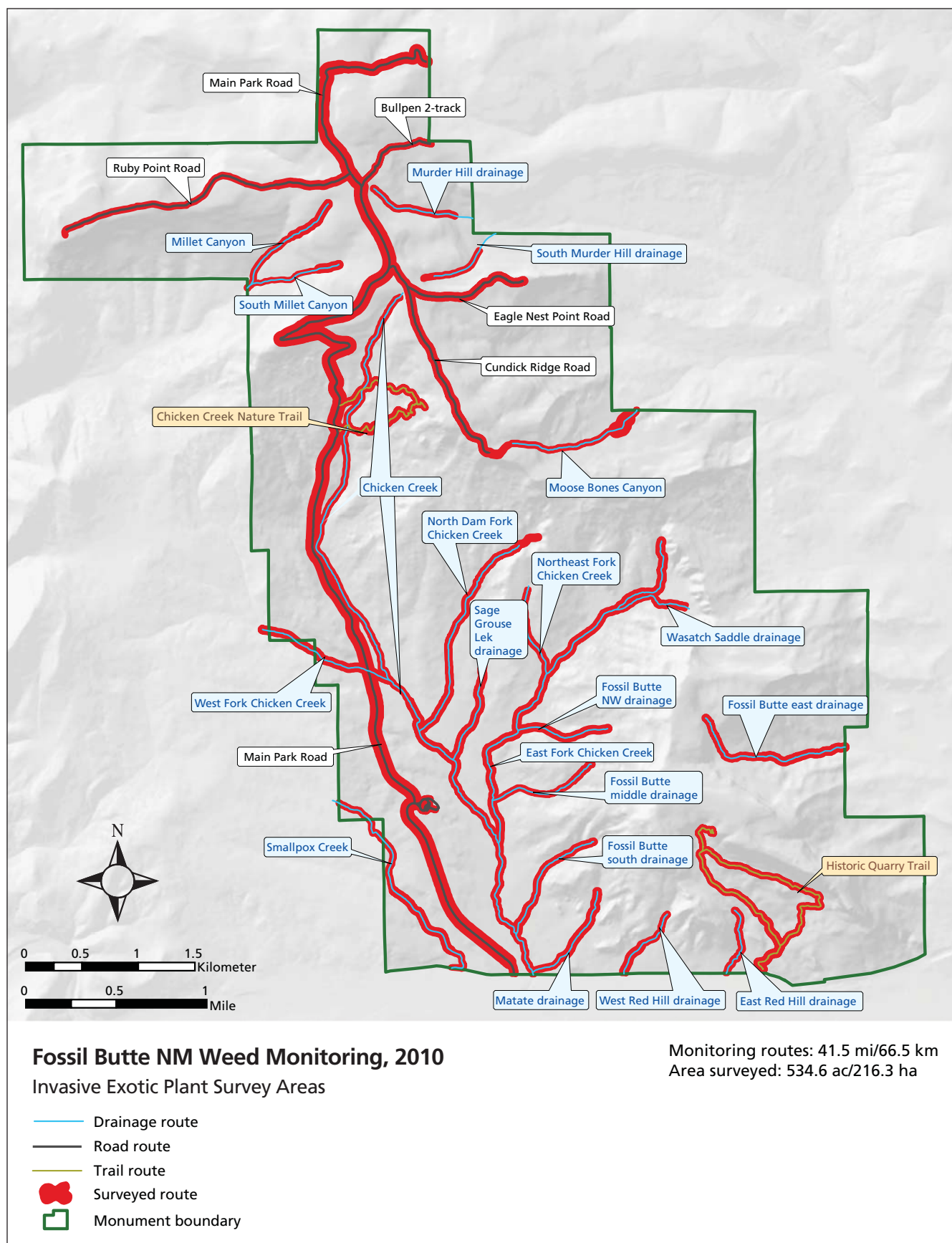


Figure 2-2. Overview of invasive plant monitoring routes surveyed at Fossil Butte National Monument, July 24–28, 2010.

Infestation size class was estimated as follows:

1. 1–a few plants (used for isolated single plants or very small patches ($\leq 2 \times 2$ m),
2. few plants–40 m² (48 yd²),
3. 40–400 m² (48–478 yd²),
4. 400–1,000 m² (0.1–0.25 acre), and
5. 1,000–2,000 m² (0.25–0.5 acre).

We recorded canopy cover class by estimating the amount, or “percentage,” of ground covered by the vertical projection of plant matter 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 of a single plant species. We recorded canopy cover of a patch 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 infestation: descriptive notes (e.g., hillside, distance to road, wetland, stream), the growth stage of exotic trees (i.e., sapling, pole, mature), evidence of prior treatment, and evidence of disturbances (e.g., recent fire, flood, small mammal disturbance).

2.3 Monitoring transects

Our methods for sampling the monitoring quadrats were based on Stohlgren and others (2005). We established transects with three vegetation quadrats every 500 m along monitoring routes (Figure 2-3). If no invasives 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 canopy cover class or infestation size class, then we went back to establishing transects every 500 m.

2.3.1 Quadrat establishment

In 2010, 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-m² 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 2008, we used three 1-m² vegetation quadrats, placed in a circular macroplot [see Perkins and Weissinger 2009]. In 2009, quadrats were placed at 3, 8, and 13 m away from the monitoring route.)

Quadrat-sampling methods differed slightly from 2008 to 2009–2010. In 2008, all invasive species were recorded in monitoring quadrats. In 2009 and 2010, only Priority 1 species and cheatgrass were recorded in the quadrats and along routes. Observers could make additional species observations, but species other than Priority 1 and cheatgrass along the Main Park Road were not reliably recorded.

2.3.2 Data collection methods

In the monitoring quadrats, we recorded cheatgrass and all Priority 1 IEP species observed. 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, 11–25, or >50%. We also recorded percent cover, to the nearest 10%, 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).

2.4 Analyses

We calculated the mean number of infestations per 100 m for monitoring routes. Percent cover estimates were generated from the monitoring quadrat data. We calculated the mean and standard error of percent cover by species for monitoring quadrats. For classes representing a range of percent cover values (11–25, 26–50, and 51–100), midpoints were used (18, 38, and 76%) when calculating the mean and standard error. Due to differences in observers’ knowledge, only Priority 1 species and cheatgrass along the Main Park Road should be used when comparing results from year to year.

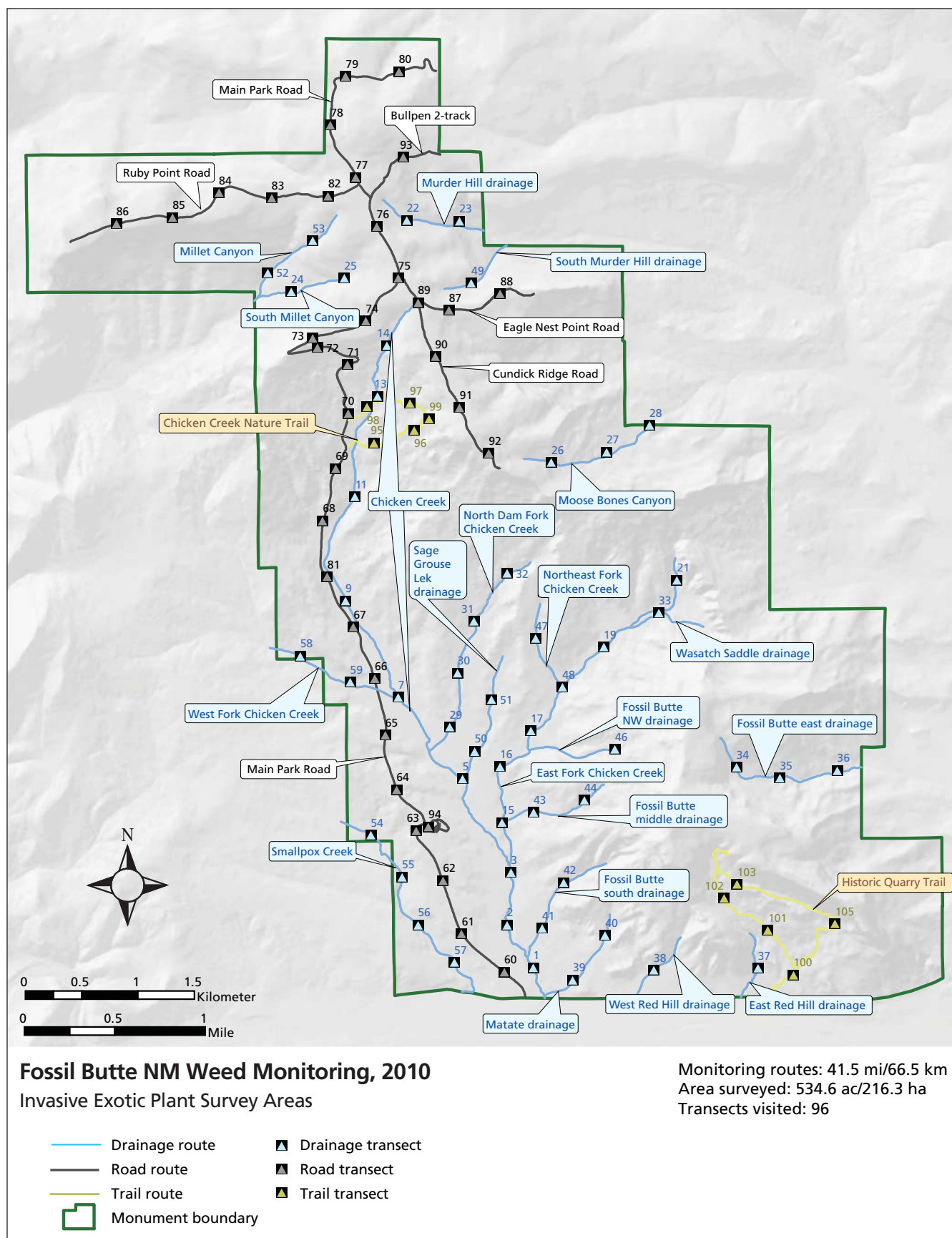


Figure 2-3. Monitoring quadrats established at Fossil Butte National Monument, July 24–28, 2010.

3 Results

3.1 Park target IEP list

Twenty-three IEP species were identified as Priority 1 for the FOBU target IEP list (Appendix A). From 2008 to 2010, at the request of park staff, we also mapped cheatgrass along the Main Park Road, but not along other monitoring routes. We also recorded cheatgrass in monitoring quadrats in 2009 and 2010. A total of 21 IEP species were recorded on monitoring routes and quadrats in 2010 (Table 3-1). Ten Priority 1 species (plus 6 additional IEPs) were recorded on monitoring routes; four Priority 1 species (plus 8 additional IEPs) were recorded in monitoring quadrats in 2010. We covered 215.1 hectares (532 acres) along monitoring routes in 2010, representing 16.0% of the entire park.

NCPN staff does not regularly control invasives while monitoring; however, they are instructed to

pull IEPs found in areas that require a significant amount of time to access. NCPN crews pulled a single yellow sweetclover (*Melilotus officinalis*) in Chicken Creek and a single yellow salsify (*Tragopogon dubius*) in the Matate Drainage.

3.2 Monitoring routes

The survey crew walked a total of 66.7 km (41.5 miles) along 27 monitoring routes in 2010 (Figures 3-1, 3-2, 3-3, 3-4). A total of 475 infestations, 320 of which were Priority 1, were detected along monitoring routes (Table 3-2, Appendix B). Dyer's woad (*Isatis tinctoria*) was the only Priority 1 species found along routes in previous years and not found in 2010. There were no new Priority 1 species detected along monitoring routes in 2010.

Quackgrass (*Elymus repens*), creeping foxtail (*Alopecurus arundinaceus*), Canada thistle (*Cirsium arvense*), yellow sweetclover, and musk thistle (*Carduus nutans*) were the most commonly detected Priority 1 IEPs. Creeping foxtail was not

Table 3-1. Invasive exotic plants detected at Fossil Butte National Monument, July 24–28, 2010.

Scientific name	Common name	Method detected		Park priority
		Routes	Quadrats	
<i>Alopecurus arundinaceus</i>	creeping foxtail	X	X	1
<i>Cardaria chalepensis</i>	lens-pod whitetop	X		1
<i>Carduus nutans</i>	musk thistle	X		1
<i>Centaurea maculosa</i>	spotted knapweed	X		1
<i>Cirsium arvense</i>	Canada thistle	X	X	1
<i>Cirsium vulgare</i>	bull thistle	X		1
<i>Convolvulus arvensis</i>	field bindweed	X		1
<i>Descurainia sophia</i>	flixweed		X	1
<i>Elymus repens</i>	quackgrass	X	X	1
<i>Hyoscyamus niger</i>	black henbane	X		1
<i>Melilotus officinalis</i>	yellow sweetclover	X		1
<i>Agropyron cristatum</i>	crested wheatgrass		X	Not on list
<i>Alyssum desertorum</i>	desert madwort		X	Not on list
<i>Bromus japonicus</i>	Japanese brome	X	X	Not on list
<i>Bromus inermis</i>	smooth brome	X	X	Not on list
<i>Bromus tectorum</i>	cheatgrass	X	X	Not on list
<i>Poa pratensis</i>	Kentucky bluegrass		X	Not on list
<i>Taraxacum officinale</i>	common dandelion		X	Not on list
<i>Tragopogon dubius</i>	yellow salsify	X	X	Not on list
<i>Trifolium pratense</i>	red clover	X		Not on list
<i>Trifolium repens</i>	white clover	X		Not on list

Only Priority 1 species were mapped and recorded in quadrats throughout FOBU. Species not on the list were opportunistic observations.

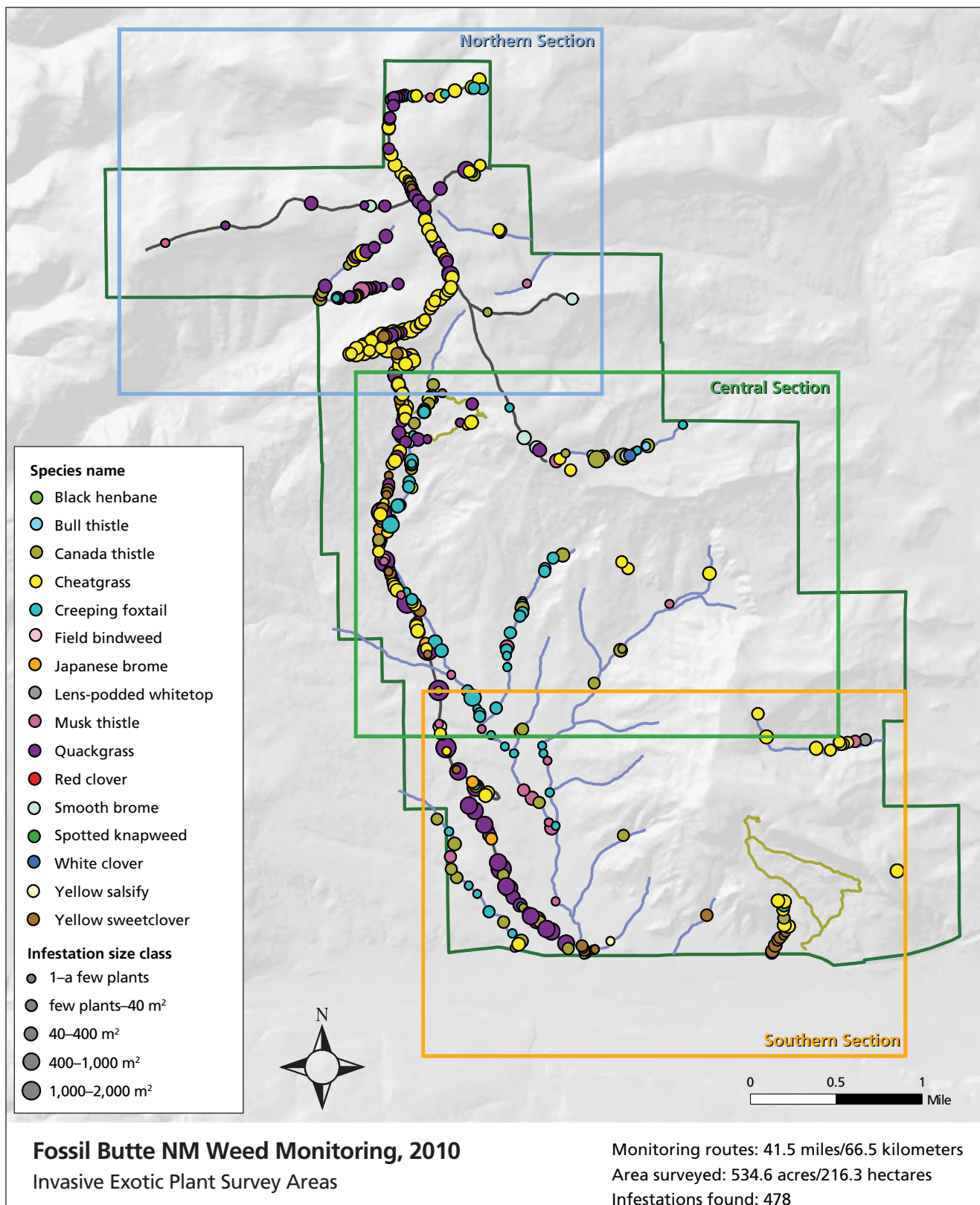


Figure 3-1. Invasive plants detected along monitoring routes, monitoring quadrats, and extra-area surveys at Fossil Butte National Monument, July 24–28, 2010.

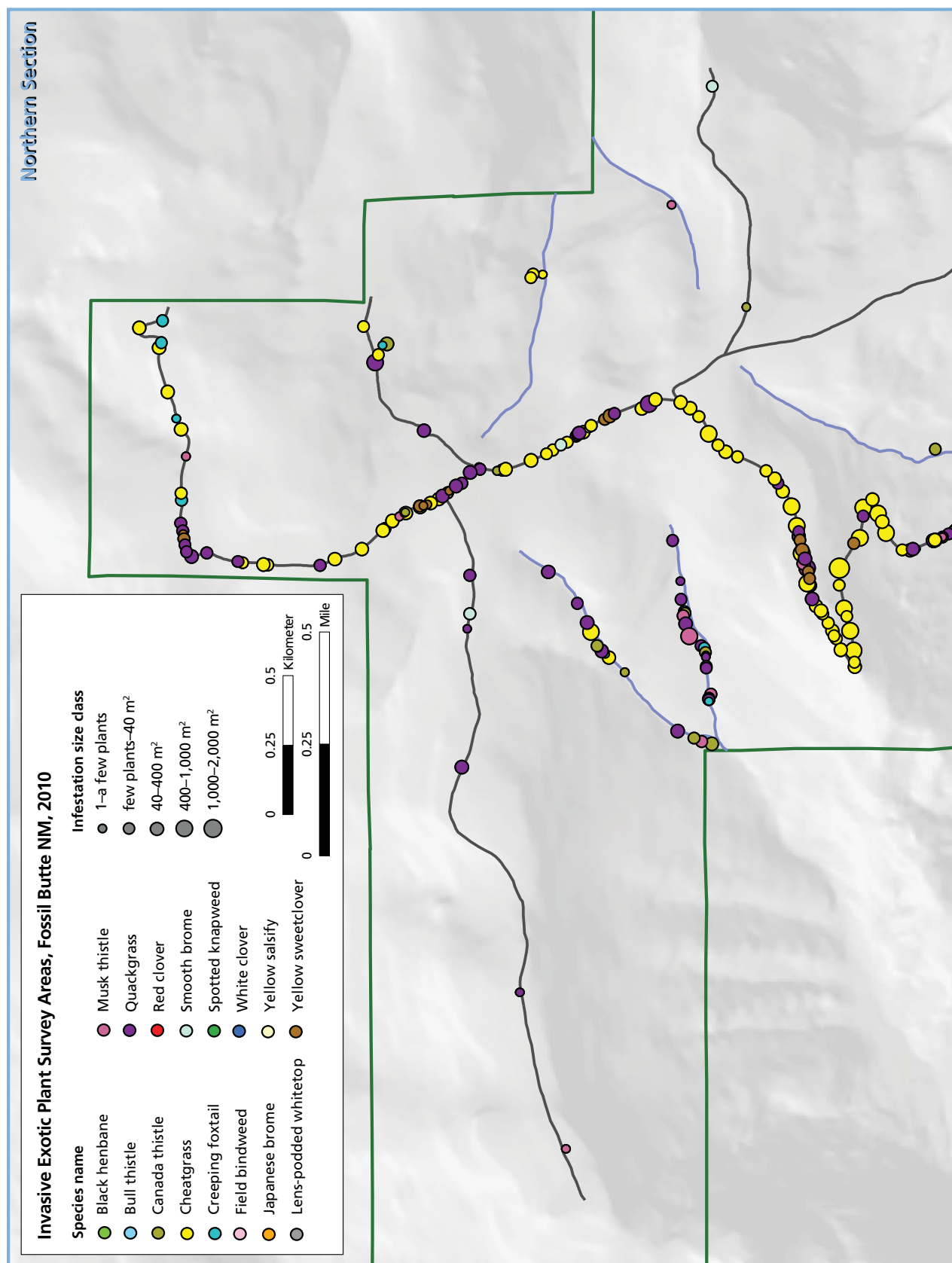


Figure 3-2. Invasive plants detected along monitoring routes and monitoring quadrats in the northern portion of Fossil Butte National Monument, July 24–28, 2010.

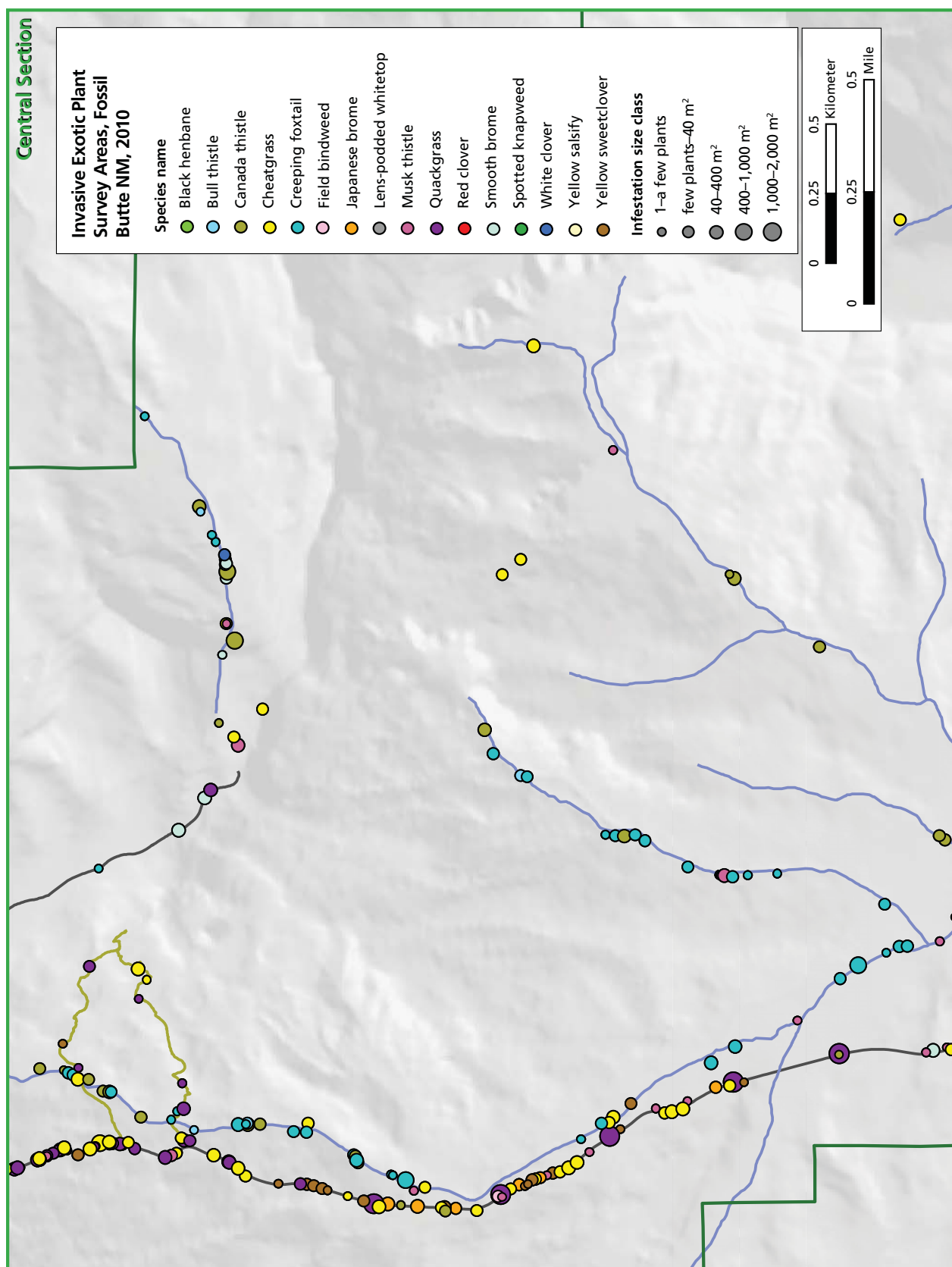


Figure 3-3. Invasive plants detected along monitoring routes and monitoring quadrats in the central portion of Fossil Butte National Monument, July 24–28, 2010.

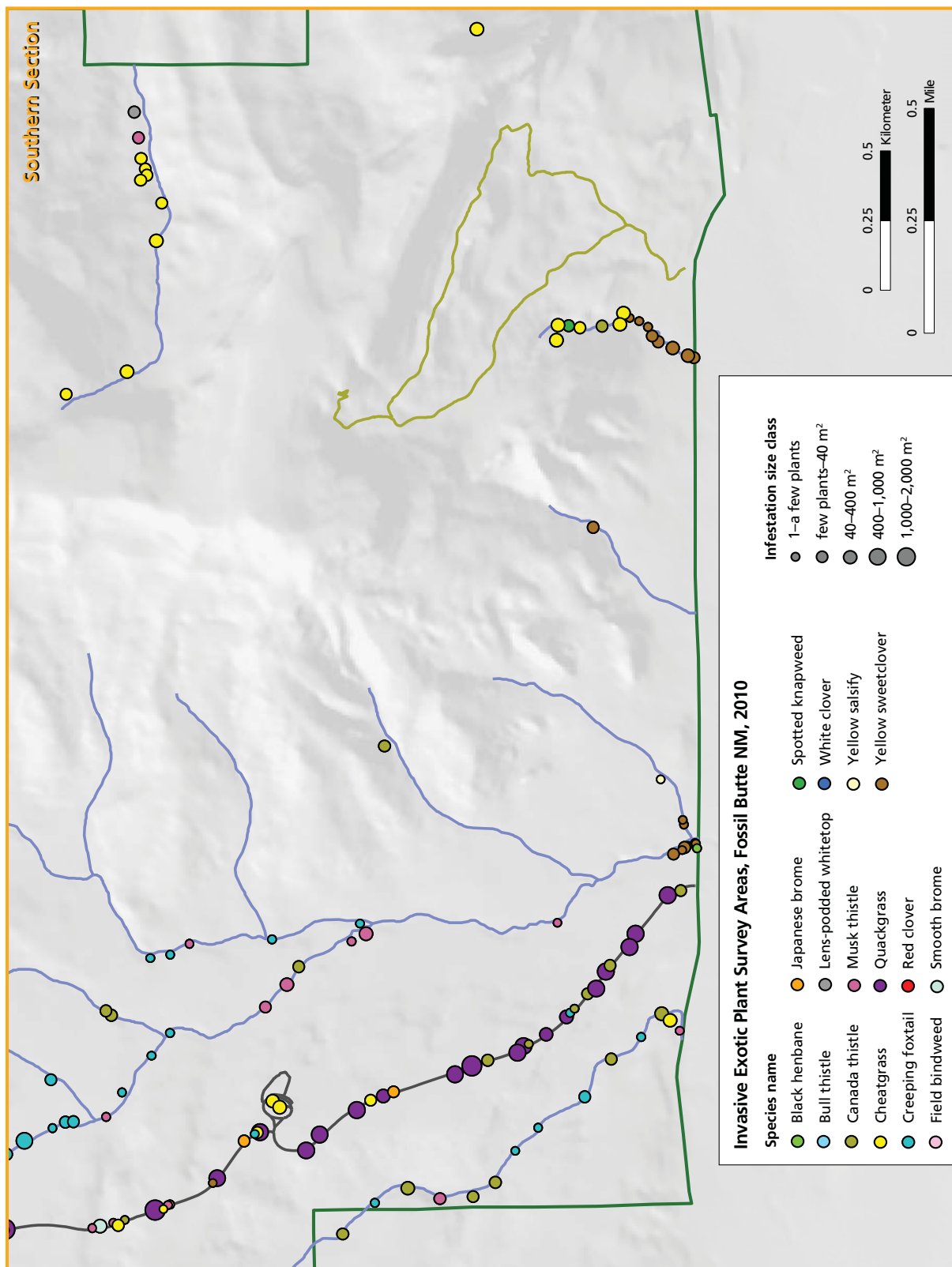


Figure 3-4. Invasive plants detected along monitoring routes and monitoring quadrats in the southern portion of Fossil Butte National Monument, July 24–28, 2010.

Table 3-2. IEP infestations per route surveyed, Fossil Butte NM, July 24–28, 2010.

Route	Type of route	Length (m)	Area (ha)	Infestations	
				Number (Priority 1)	Number/ha (Priority 1)
Main Park Road	Road	23,191	86.70	250 (139)	2.88 (1.60)
Bullpen Two-Track	Road	832	1.59	6 (4)	3.78 (2.52)
Cundick Ridge Road	Road	2,068	8.47	4 (2)	0.47 (0.24)
Eagle Nest Point Road	Road	1,134	4.50	2 (1)	0.44 (0.22)
Ruby Point Road	Road	2,740	6.81	9 (7)	1.32 (1.03)
<i>Roads Other Than Main Park Road</i>		<i>6,774</i>	<i>21.37</i>	<i>21 (14)</i>	<i>0.98 (0.66)</i>
Chicken Creek	Riparian	7,152	18.14	51 (47)	2.81 (2.59)
East Fork Chicken Creek	Riparian	3,619	14.38	10 (9)	0.70 (0.63)
East Red Hill Drainage	Riparian	653	1.60	15 (10)	9.40 (6.27)
Fossil Butte East Drainage	Riparian	1,514	5.41	10 (2)	1.85 (0.37)
Fossil Butte Middle Drainage	Riparian	1,018	2.24	0 (0)	0.00 (0.00)
Fossil Butte NW Drainage	Riparian	838	3.34	0 (0)	0.00 (0.00)
Fossil Butte South Drainage	Riparian	1,167	3.75	1 (1)	0.27 (0.27)
Matate Drainage	Riparian	1,000	3.56	3 (2)	0.84 (0.56)
Millet Canyon	Riparian	1,090	3.16	13 (11)	4.11 (3.48)
Moose Bones Canyon	Riparian	1,248	4.31	21 (13)	4.87 (3.01)
Murder Hill Drainage	Riparian	800	1.97	3 (0)	1.53 (0.00)
NE Fork Chicken Creek	Riparian	841	2.10	0 (0)	0.24 (0.00)
N. Dam Fork Chicken Cr.	Riparian	2,231	7.09	17 (17)	2.40 (2.40)
Sage Grouse Lek Drainage	Riparian	1,236	4.92	3 (3)	0.61 (0.61)
Smallpox Creek	Riparian	2,228	5.93	15 (14)	2.53 (2.36)
South Millet Canyon	Riparian	822	1.47	21 (21)	14.29 (14.29)
S. Murder Hill Drainage	Riparian	620	1.21	1 (1)	0.83 (0.83)
Wasatch Saddle Drainage	Riparian	727	1.95	0 (0)	0.00 (0.00)
West Fork Chicken Creek	Riparian	1,249	4.64	0 (0)	0.00 (0.00)
West Red Hill Drainage	Riparian	700	2.06	1 (1)	0.49 (0.49)
<i>All Riparian</i>		<i>30,753</i>	<i>93.23</i>	<i>185 (152)</i>	<i>1.98 (1.63)</i>
Chicken Creek Nature Trail	Trail	2,118	4.72	19 (15)	4.03 (3.18)
Historic Quarry Trail	Trail	3,903	9.05	0 (0)	0.00 (0.00)
<i>All Trails</i>		<i>6,021</i>	<i>13.77</i>	<i>19 (15)</i>	<i>1.40 (1.09)</i>
Total		66,739	215.07	475 (320)	2.21 (1.49)

*One additional location of cheatgrass was noted east of the Historic Quarry trail while the observer was moving between monitoring routes.

recorded anywhere in the park in 2008, due to mis-identification, but was recorded in several places in 2009. Flixweed was not recorded anywhere along the monitoring routes in 2010, despite being one of the most prevalent species in 2009. This result likely occurred because the field staff was not properly trained to identify this species and should not be construed as a drastic reduction in the presence of flixweed. Only Priority 1 species throughout the park, and cheatgrass along the Main Park Road, should be examined when comparing years and areas, as these were the only species recorded consistently by all observers and in all years. In 2010, IEPs were most prevalent in South Millet Canyon, East Red Hill Drainage, Moose Bones Canyon, and Millet Canyon.

Routes or sections of routes located away from roads and areas of high visitation generally had

lower numbers of IEP invasions. No Priority 1 IEPs were detected on the Historic Quarry Trail, Fossil Butte Middle Drainage, Fossil Butte NW Drainage, Murder Hill Drainage, Wasatch Saddle Drainage, or northeast and west forks of Chicken Creek. A large area in the southern portion of the park, along the major invasive pathways around Fossil Butte, appears to be mostly free of Priority 1 species (Figure 3-4). In 2009, there were no infestations found in this area. In 2010, two infestations were found: Canada thistle at the Fossil Butte South Drainage and yellow sweetclover in the West Red Hill Drainage.

Of the 475 Priority 1 infestations, 75% were classified as infestations in either the “1–a few plants” (1) or “few plants–40 m²” (2) size classes (Table 3-3). Riparian areas and the Main Park Road had the highest densities of infestations.

Table 3-3. Species observed and size of infestation detected along monitoring routes at Fossil Butte NM on July 24–28, 2010.

Scientific name	Common name	Total infestations	Infestation size class Number of infestations				
			1	2	3	4	5
Priority 1 species							
<i>Alopecurus arundinaceus</i> [^]	creeping foxtail	63	33	24	4	2	0
<i>Cardaria</i> sp.	whitetop	1	0	1	0	0	0
<i>Carduus nutans</i>	musk thistle	37	24	7	5	1	0
<i>Centaurea maculosa</i>	spotted knapweed	1	0	1	0	0	0
<i>Cirsium arvense</i>	Canada thistle	54	12	30	10	2	0
<i>Cirsium vulgare</i>	bull thistle	9	6	3	0	0	0
<i>Convolvulus arvensis</i>	field bindweed	1	0	1	0	0	0
<i>Elymus repens</i>	quackgrass	95	12	31	29	16	7
<i>Hyoscyamus niger</i>	black henbane	5	4	1	0	0	0
<i>Melilotus officinalis</i>	yellow sweetclover	54	28	21	5	0	0
Priority 1 species		320	119	120	53	21	7
Non-priority species*							
<i>Bromus inermis</i>	smooth brome	11	2	6	3	0	0
<i>Bromus japonicus</i>	Japanese brome	10	1	7	2	0	0
<i>Bromus tectorum</i> **	cheatgrass	131	4	53	59	14	1
<i>Tragopogon dubius</i>	yellow salsify	1	1	0	0	0	0
<i>Trifolium pratense</i>	red clover	1	0	1	0	0	0
<i>Trifolium repens</i>	white clover	1	0	1	0	0	0
Non-priority species		155	8	68	64	14	1
All species		475	127	188	117	35	8

[^]Species was not searched for in 2008.

*Non-priority species may not have been recorded on all routes in both years.

***Bromus tectorum* was only regularly recorded along the Main Park Road in 2008, but was recorded everywhere in 2009 and 2010.

Infestation size classes: (1) 1–a few plants, (2) few plants–40 m² (48 yd²), (3) 40–400 m² (48–478 yd²), (4) 400–1,000 m² (0.1–0.25 acre), and (5) 1,000–2,000 m² (0.25–0.5 acre)

Of all three years when Chicken Creek was surveyed (2008–2010), the number of Priority 1 infestations detected was highest in 2010 (Table 3-4). Creeping foxtail and yellow sweetclover showed the biggest increases.

Monitoring was conducted along the entire Main Park Road in 2008 and 2010, and along portions of the road in 2009. Staff from the park and the Exotic Plant Management Team that serves it performed several IEP control efforts in between the 2008 and 2010 monitoring field seasons, focusing on Canada thistle, bull thistle (*Cirsium vulgare*), musk thistle, sweetclover, and black henbane (*Hyoscyamus niger*). Infestations of Canada thistle and black henbane decreased, while musk thistle and quackgrass (*Elymus repens*) increased between 2008 and 2010. Cheatgrass control efforts occurred in 2008 and 2009, and intensified in 2010; however, a large portion of these efforts occurred after monitoring had been conducted. More and larger infestations of cheatgrass were present in 2010 than in 2008 (Table 3-5).

In all other portions of the park (southern drainages, northern drainages, northern roads, and park trails) Priority 1 IEPs increased in 2010 compared to when they were surveyed in 2008 or 2009 (Tables 3-6, 3-7, 3-8, 3-9). Creeping foxtail and quackgrass showed the biggest increases.

3.3 Monitoring quadrats

A total of 96 quadrats were sampled in 2010 (see Figure 2-3, Appendix C). Only Priority 1 species and cheatgrass have been reliably recorded in all years. In 2010, four Priority 1 species, seven other IEP species, and cheatgrass were detected in quadrats. Only one Priority 1 species and cheatgrass were recorded in the last comprehensive survey of park quadrats, done in 2008 and 2009. In 2010, creeping foxtail occurred in one plot in the North Dam Fork of Chicken Creek. Canada thistle occurred in one plot each in Moose Bones Canyon and Smallpox Creek. Quackgrass occurred in four quadrats along the Main Park Road, with an estimated cover of 0.64%. It also occurred in one plot in Millet Canyon. Flixweed occurred in two quadrats along the Main Park Road. Cheatgrass occurred in nine quadrats along the Main Park Road, with an estimated cover of 0.36%. In 2009, cheatgrass was detected in two quadrats along the Main Park Road, with an estimated cover of 0.33%, and was detected in one quadrat along the Historic Quarry Trail.

Table 3-4. Species observed and size of infestations detected at Chicken Creek, Fossil Butte NM, July 14–15, 2008, August 6–8, 2009, and July 24–28, 2010.

Scientific name	Common name	Year	Total infestations	Infestation size class			
				Number of infestations			
				1	2	3	4
<i>Alopecurus arundinaceus</i> [^]	creeping foxtail	2008	NA	NA	NA	NA	NA
		2009	12	2	7	1	2
		2010	21	7	8	4	2
<i>Bromus tectorum</i> [*]	cheatgrass	2008	1	0	1	0	0
		2009	1	0	1	0	0
		2010	4	0	3	1	0
<i>Carduus nutans</i>	musk thistle	2008	3	2	1	0	0
		2009	5	1	4	0	0
		2010	9	6	1	2	0
<i>Cirsium arvense</i>	Canada thistle	2008	9	6	2	1	0
		2009	13	8	4	1	0
		2010	7	0	6	1	0
<i>Cirsium vulgare</i>	bull thistle	2008	0	0	0	0	0
		2009	3	2	1	0	0
		2010	2	1	1	0	0
<i>Elymus repens</i>	quackgrass	2008	1	0	0	1	0
		2009	1	0	1	0	0
		2010	0	0	0	0	0
<i>Hyoscamus niger</i>	black henbane	2008	0	0	0	0	0
		2009	0	0	0	0	0
		2010	1	1	0	0	0
<i>Melilotus officinalis</i>	yellow sweetclover	2008	0	0	0	0	0
		2009	3	0	2	1	0
		2010	7	4	3	0	0
Total Priority 1		2008	13	8	3	2	0
		2009	37	13	19	3	2
		2010	47	19	19	7	2
Total Priority 1, no <i>A. arundinaceus</i>		2009	25	11	12	2	0
		2010	26	12	11	3	0

[^]Species was not searched for in 2008.

*Not a Priority 1 species so may not have been searched for by all observers in both years.

Infestation size classes: (1) 1–a few plants, (2) few plants–40 m² (48 yd²), (3) 40–400 m² (48–478 yd²), (4) 400–1,000 m² (0.1–0.25 acre), and (5) 1,000–2,000 m² (0.25–0.5 acre)

Table 3-5. Species observed and size of infestation detected along the Main Park Road, Fossil Butte NM, July 14–15, 2008 and July 24–28, 2010.*

Scientific name	Common name	Year	Total infestations (per 100 m)	Infestation size class				
				Number of infestations				
				1	2	3	4	5
<i>Alopecurus arundinaceus</i> [^]	creeping foxtail	2010	6 (0.03)	3	3	0	0	0
<i>Bromus tectorum</i> ^{**}	cheatgrass	2008	37 (0.20)	15	12	9	1	0
		2010	95 (0.41)	2	35	44	13	1
<i>Cardaria chalapensis</i>	orbicular whitetop	2008	2 (0.01)	1	1	0	0	0
		2010	0 (0.00)	0	0	0	0	0
<i>Carduus nutans</i>	musk thistle	2008	6 (0.03)	4	2	0	0	0
		2010	14 (0.06)	12	1	1	0	0
<i>Cirsium arvense</i>	Canada thistle	2008	29 (0.15)	12	16	1	0	0
		2010	12 (0.05)	7	5	0	0	0
<i>Cirsium vulgare</i>	bull thistle	2008	1 (0.01)	0	1	0	0	0
		2010	1 (0.004)	1	0	0	0	0
<i>Convolvulus arvensis</i>	field bindweed	2008	4 (0.02)	0	4	0	0	0
		2010	1 (0.004)	0	1	0	0	0
<i>Elymus repens</i>	quackgrass	2008	49 (0.26)	19	16	12	2	0
		2010	69 (0.30)	5	23	19	15	7
<i>Hyoscyamus niger</i>	black henbane	2008	16 (0.09)	15	0	1	0	0
		2010	2 (0.01)	2	0	0	0	0
<i>Melilotus officinalis</i>	yellow sweetclover	2008	48 (0.26)	38	7	3	0	0
		2010	35 (0.15)	18	14	3	0	0
Total Priority 1		2008	155 (0.82)	89	47	17	2	0
		2010	138 (0.60)	46	47	23	15	7

[^]Species was not searched for in 2008, but was Priority 1 in 2009-2010.

*18,793 m in 2008 and 23,192 m in 2010

**Not a Priority 1 species, but was searched for along the Main Park Road in both years.

Infestation size classes: (1) 1–a few plants, (2) few plants–40 m² (48 yd²), (3) 40–400 m² (48–478 yd²), (4) 400–1,000 m² (0.1–0.25 acre), and (5) 1,000–2,000 m² (0.25–0.5 acre)

Table 3-6. Priority 1 species observed and size of infestations detected on the southern drainages, Fossil Butte NM, August 6–8, 2009 and July 24–28, 2010.*

Scientific name	Common name	Year	Total infestations (per 100 m)	Infestation size class				
				Number of infestations				
				1	2	3	4	5
<i>Alopecurus arundinaceus</i>	creeping foxtail	2009	10 (0.06)	8	1	1	0	0
		2010	22 (0.13)	13	9	0	0	0
<i>Cardaria chalepensis</i>	orbicular whitetop	2009	0 (0.00)	0	0	0	0	0
		2010	1 (0.01)	0	1	0	0	0
<i>Carduus nutans</i>	musk thistle	2009	8 (0.05)	6	2	0	0	0
		2010	7 (0.04)	4	2	1	0	0
<i>Centaurea maculosa</i>	spotted knapweed	2009	0 (0.00)	0	0	0	0	0
		2010	1 (0.01)	0	1	0	0	0
<i>Cirsium arvense</i>	Canada thistle	2009	12 (0.07)	3	4	2	3	0
		2010	15 (0.09)	1	9	5	0	0
<i>Cirsium vulgare</i>	bull thistle	2009	1 (0.01)	1	0	0	0	0
		2010	1 (0.01)	0	1	0	0	0
<i>Elymus repens</i>	quackgrass	2009	2 (0.01)	0	2	0	0	0
		2010	0 (0.00)	0	0	0	0	0
<i>Hyoscyamus niger</i>	black henbane	2009	0 (0.00)	0	0	0	0	0
		2010	1 (0.01)	1	0	0	0	0
<i>Isatis tinctoria</i>	Dyer's woad	2009	2 (0.01)	2	0	0	0	0
		2010	0 (0.00)	0	0	0	0	0
<i>Melilotus officinalis</i>	yellow sweetclover	2009	3 (0.02)	0	1	2	0	0
		2010	11 (0.06)	5	4	2	0	0
Total		2009	38 (0.22)	20	10	5	3	0
		2010	59 (0.34)	24	27	8	0	0

*Southern drainages consist of all Chicken Creek tributaries, Red Hill, and Fossil Butte drainages. In 2009, 17,056 m were searched; in 2010, 17,294 m were searched.

Infestation size classes: (1) 1–a few plants, (2) few plants–40 m² (48 yd²), (3) 40–400 m² (48–478 yd²), (4) 400–1,000 m² (0.1–0.25 acre), and (5) 1,000–2,000 m² (0.25–0.5 acre)

Table 3-7. Species observed and size of infestations detected on the northern drainages, Fossil Butte NM, August 6–8, 2009 and July 24–28, 2010.*

Scientific name	Common name	Year	Total infestations (per 100 m)	Infestation size class				
				Number of infestations				
				1	2	3	4	5
<i>Alopecurus arundinaceus</i>	creeping foxtail	2009	2 (0.05)	0	2	0	0	0
		2010	8 (0.21)	6	2	0	0	0
<i>Carduus nutans</i>	musk thistle	2009	7 (0.18)	5	2	0	0	0
		2010	7 (0.19)	2	3	1	1	0
<i>Cirsium arvense</i>	Canada thistle	2009	10 (0.26)	3	5	2	0	0
		2010	13 (0.34)	2	7	2	2	0
<i>Cirsium vulgare</i>	bull thistle	2009	1 (0.03)	1	0	0	0	0
		2010	4 (0.11)	3	1	0	0	0
<i>Elymus repens</i>	quackgrass	2009	0 (0.00)	0	0	0	0	0
		2010	13 (0.34)	2	6	5	0	0
<i>Hyoscyamus niger</i>	black henbane	2009	1 (0.03)	1	0	0	0	0
		2010	1 (0.03)	0	1	0	0	0
Total		2009	21 (0.54)	10	9	2	0	0
		2010	46 (1.22)	15	20	8	3	0

*Northern drainages consist of Millet Canyon, South Millet Canyon, South Murder Hill, and Moose Bones Canyon. In 2009, 3,877 m were searched; in 2010, 3,780 m were searched.

Infestation size classes: (1) 1–a few plants, (2) few plants–40 m² (48 yd²), (3) 40–400 m² (48–478 yd²), (4) 400–1,000 m² (0.1–0.25 acre), and (5) 1,000–2,000 m² (0.25–0.5 acre)

Table 3-8. Species observed and size of infestations detected along northern roads, Fossil Butte NM, July 14–15, 2008 and July 24–28, 2010.*

Scientific name	Common name	Year	Total infestations (per 100 m)	Infestation size class				
				Number of infestations				
				1	2	3	4	5
<i>Alopecurus arundinaceus</i>	creeping foxtail	2008	0 (0.00)	0	0	0	0	0
		2010	2 (0.03)	2	0	0	0	0
<i>Carduus nutans</i>	musk thistle	2008	1 (0.02)	1	0	0	0	0
		2010	1 (0.01)	1	0	0	0	0
<i>Cirsium arvense</i>	Canada thistle	2008	0 (0.00)	0	0	0	0	0
		2010	3 (0.04)	1	1	1	0	0
<i>Elymus repens</i>	quackgrass	2008	1 (0.02)	0	1	0	0	0
		2010	8 (0.12)	2	1	4	1	0
Total		2009	2 (0.03)	1	1	0	0	0
		2010	14 (0.21)	6	2	5	1	0

*Northern roads consist of Ruby Point, Bullpen 2-Track, Eagle Nest, and Cundick Ridge. In 2008, 6,638 m were searched; in 2010, 6,774 m were searched.

Infestation size classes: (1) 1–a few plants, (2) few plants–40 m² (48 yd²), (3) 40–400 m² (48–478 yd²), (4) 400–1,000 m² (0.1–0.25 acre), and (5) 1,000–2,000 m² (0.25–0.5 acre)

Table 3-9. Species observed and size of infestations detected along Chicken Creek Nature Trail (2008 and 2010) and Historic Fossil Quarry Trail*, Fossil Butte NM, July 14–15, 2008, August 6–8, 2009, and July 24–28, 2010.

Scientific name	Common name	Year	Total infestations (per 100 m)	Infestation size class				
				Number of infestations				
				1	2	3	4	5
<i>Alopecurus arundinaceus</i>	creeping foxtail	2008–2009	0 (0.00)	0	0	0	0	0
		2010	4 (0.07)	2	2	0	0	0
<i>Cirsium arvense</i>	Canada thistle	2008–2009	1 (0.02)	0	1	0	0	0
		2010	4 (0.07)	1	2	1	0	0
<i>Cirsium vulgare</i>	bull thistle	2008–2009	1 (0.02)	1	0	0	0	0
		2010	1 (0.02)	1	0	0	0	0
<i>Elymus repens</i>	quackgrass	2008–2009	0 (0.00)	0	0	0	0	0
		2010	5 (0.08)	3	1	1	0	0
<i>Hyoscyamus niger</i>	black henbane	2008–2009	2 (0.04)	1	1	0	0	0
		2010	0 (0.00)	0	0	0	0	0
<i>Melilotus officinalis</i>	yellow sweetclover	2008–2009	0 (0.00)	0	0	0	0	0
		2010	1 (0.02)	1	0	0	0	0
Total		2008–2009	4 (0.07)	2	2	0	0	0
		2010	15 (0.25)	8	5	2	0	0

*3,476 m in 2009 and 3,903 m in 2010

Infestation size classes: (1) 1–a few plants, (2) few plants–40 m² (48 yd²), (3) 40–400 m² (48–478 yd²), (4) 400–1,000 m² (0.1–0.25 acre), and (5) 1,000–2,000 m² (0.25–0.5 acre)

4 Discussion

4.1 Priority 1 IEP List

The NCPN will continue to work with park staff and area weed experts to review and update the list of Priority 1 species each year. Presence and absence data for most Priority 1 species and cheatgrass along the Main Park Road should be reliable; however, absence data for other species is suspect, because they are not consistently recorded from year to year. Flixweed was difficult for field crews to identify in 2010; extra training will occur before the next field visit to FOBU in 2012.

Quackgrass was also difficult to identify. The majority of true *Elymus repens* was found along the Main Park Road, but there was also a large number of hybrid plants, in which *Elymus repens* had crossed with native *Elymus*. The two crew members did not map the true and hybrid quackgrass consistently. The hybrid was widespread throughout the park, and is often glaucous. Because of this difficulty in identification, the hybridization issue, and the extensiveness of the hybrid, NCPN and park staff may want to consider (1) removing *Elymus repens* from the Priority 1 species list or (2) including both the hybrid and true quackgrass on the Priority 1 list.

One new record was found and collected for the park: red clover (*Trifolium pratense*), in Moose Bones Canyon.

4.2 Possibilities for management control

Control efforts for targeted species appear to be working. Invasive exotic plants were widespread along the Main Park Road in 2008, but declined in 2010 after control efforts. However, cheatgrass continues to increase in both number and size of infestations. Extensive control efforts for cheatgrass occurred after surveys took place in 2010, so results from the next visit, in 2012, may show the benefits of these efforts.

In most cases, crews performing control efforts document the total species removed for the park, but do not designate the specific areas from which they were removed. For example, in 2010, personnel mechanically removed 15,996

and 3,584 yellow sweetclover and musk thistle plants, respectively. In 2009, yellow sweetclover infestations were mechanically removed and musk thistle infestations were sprayed, but total numbers are not available. NCPN staff is working with park staff to obtain more specific location information for future control efforts, so they can be matched to monitoring data.

The data from monitoring routes are meant to provide information for control efforts. Unlike the monitoring transects and associated quadrats, the routes are not designed to make statistical comparisons between years and areas. However, large changes in infestations are likely to represent biological realities. Overall, there appeared to be more Priority 1 IEP infestations present in FOBU in 2010 than when surveys were last done in 2008 and 2009. Quadrat data also showed more Priority 1 invasives in 2010 than 2008–2009. While it is encouraging that 75% of Priority 1 infestations detected on monitoring routes were less than 40 m² in size, it is discouraging that this number has decreased from 84% in 2009, indicating an increase in the percentage of infestations of larger sizes, which are harder to control.

Areas away from roads and with lower human visitation continued to have fewer IEPs. Efforts should be made to ensure that the area around Fossil Butte, which is largely free of Priority 1 IEPs, is maintained. This area had no infestations in 2009, but had two in 2010, so efforts should be made to control the few infestations present.

Park managers may also want to focus efforts on South Millet Canyon, East Red Hill Drainage, Millet Canyon, and Moose Bones Canyon, which have infestation levels higher than those of Chicken Creek and the Main Park Road, where existing efforts are continuing. East Red Hill Drainage is particularly important, as it is nearby to the large weed-free area.

It should be noted that estimates of percent cover in this report (see Section 3.3) are limited to the routes surveyed; actual percent cover of IEPs across the entire park cannot be inferred with these methods. Because we have chosen to monitor along 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 interior of the park than along the monitoring routes.

4.3 Future monitoring efforts

IEPs at FOBU will generally be monitored at the same time of year, every other year. Consistency in timing of monitoring should ensure consistency in detection probabilities and cover estimates of most species. For many species, sampling at any time from May to September is not expected to drastically alter the chances of detecting invasive species larger than the minimum detection target size. In 2012, the NCPN will re-survey all of the areas covered in 2008–2010. The monitoring quadrats are re-located each year because any detections from a previous year could have

been eradicated by park staff. A complete second sample of monitoring quadrats will be collected in 2012; these will be compared to the samples collected in 2008–2010. Long-term trend reporting will focus on trends in species distributions, trends in percent cover of individual species, and changes in IEP percent cover of Priority 1 species and cheatgrass by monitoring route. Extra-area surveys will also be considered for inventories at the park's request. The NCPN's invasive plant monitoring protocol was submitted for peer review in December 2010.

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Appendix A. Fossil Butte National Monument Priority 1 Invasive Exotic Plant List

Species name (Utah)	Common name
<i>Alopecurus arundinaceus</i>	creeping foxtail
<i>Arctium minus</i>	burdock
<i>Cardaria chalapensis</i>	orbicular whitetop
<i>Cardaria pubescens</i>	hairy whitetop
<i>Carduus nutans</i>	musk thistle
<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>	flixweed
<i>Elymus repens</i>	quackgrass
<i>Hyoscyamus niger</i>	black henbane
<i>Isatis tinctoria</i>	Dyer's woad
<i>Kochia scparia</i>	kochia
<i>Lepidium latifolium</i>	perennial pepperweed
<i>Linaria dalmatica</i>	Dalmatian toadflax
<i>Melilotus officinalis</i>	yellow sweetclover
<i>Sonchus arvensis/S. ulginosis</i>	perennial sowthistle
<i>Tamarix</i> spp.	tamarisk
<i>Verbascum thapsus</i>	woolly mullein

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Fossil Butte NM, July 24–28, 2010

Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing	Easting
Bullpen two-track	<i>Cirsium arvense</i>	Canada thistle	3	3	No	4637490.932	518854.705
	<i>Alopecurus arundinaceus</i>	creeping foxtail	1	5	No	4637507.296	518849.839
	<i>Bromus tectorum</i>	cheatgrass	2	5	No	4637573.821	518917.572
			2	3	No	4637521.632	518815.099
Chicken Creek	<i>Elymus repens</i>	quackgrass	3	2	No	4637357.064	518543.801
			4	2	No	4637532.991	518788.908
	<i>Hyoscyamus niger</i>	black henbane	1	3	No	4630169.679	519894.633
	<i>Cirsium vulgare</i>	bull thistle	1	3	No	4634964.328	518255.763
			2	2	No	4634773.345	518277.803
	<i>Cirsium arvense</i>	Canada thistle	3	3	No	4634771.572	518274.67
			2	3	No	4634375.706	518138.099
			2	4	No	4634728.73	518275.483
			2	3	No	4634386.035	518161.129
			2	3	No	4631596.318	519470.024
			2	3	No	4635519.199	518475.574
			2	2	No	4635155.493	518301.326
	<i>Alopecurus arundinaceus</i>	creeping foxtail	1	3	No	4634779.177	518275.171
			1	3	No	4634258.265	518096.1
			1	3	No	4634250.023	518092.331
			1	3	No	4633575.73	518222.126
			1	3	No	4632478.764	518891.846
			1	3	No	4632230.702	519020.201
			1	3	No	4632124.386	519151.8
			3	4	No	4634806.45	518273.748
			3	3	No	4634382.172	518146.252
			3	2	No	4633107.156	518495.447

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Fossil Butte NM, July 24–28, 2010, cont.

Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing	Easting
Chicken Creek	<i>Alopecurus arundinaceus</i>	creeping foxtail	3	1	No	4633021.919	518554.089
			4	3	No	4634204.234	518075.9
			4	3	No	4632579.097	518846.308
			2	3	No	4634607.645	518249.688
			2	2	No	46344561.9	518246.08
			2	2	No	4634391.81	518166.064
			2	2	No	4633501.942	518278.677
			2	3	No	4632644.621	518798.353
			2	2	No	4632432.47	518913.407
			2	2	No	4632404.527	518914.509
			2	2	No	4635261.873	518392.3
			3	3	No	4633459.665	518301.601
			2	4	No	4633475.256	518281.64
	<i>Bromus tectorum</i>	cheatgrass	2	4	No	4634135.42	518049.373
			2	3	No	4634555.589	518279.034
	<i>Carduus nutans</i>	musk thistle	1	3	No	4630249.092	519875.653
			1	3	No	4630670.071	519627.999
			1	3	No	4631408.666	519561.045
			1	3	No	4632287.412	518932.594
			1	3	No	4632798.186	518648.737
			1	4	No	4634175.93	518036.385
			3	2	No	4631356.679	519588.408
			3	2	No	4631639.96	519406.146
			2	3	No	4631715.618	519326.276
	<i>Melilotus officinalis</i>	yellow sweetclover	1	2	No	4630175.066	519911.424
			1	2	No	4630204.821	519903.449
			1	3	No	4630223.901	519888.743
			1	3	Yes	4630177.703	519915.418

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Fossil Butte NM, July 24–28, 2010, cont.

Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing	Easting
Chicken Creek	<i>Melilotus officinalis</i>	yellow sweetclover	2	3	No	4630214.646	519897.277
			2	2	No	4630253.816	519875.309
			2	3	No	4633395.632	518350.476
Cundick Ridge road	<i>Alopecurus arundinaceus</i>	creeping foxtail	1	5	No	4635306.427	519193.397
			3	4	No	4634905.313	519475.271
			3	5	No	4635020.984	519330.333
Eagle Nest Point road	<i>Bromus inermis</i>	smooth brome	3	2	No	4634927.607	519446.845
			1	5	No	4636198.297	518987.161
			2	5	No	4636320.332	519782.188
East Fork Chicken Creek	<i>Cirsium arvense</i>	Canada thistle	1	3	No	4633041.619	520249.953
			3	2	No	4633024.192	520234.636
			2	2	No	4632718.861	519989.898
	<i>Alopecurus arundinaceus</i>	creeping foxtail	1	3	No	4631378.16	519626.182
			1	3	No	4631692.559	519568.501
			1	3	No	4632129.304	519501.961
	<i>Bromus tectorum</i>	cheatgrass	1	3	No	4632057.283	519512.68
			3	3	No	4633745.327	521069.885
			1	4	No	4631988.614	519551.64
East of Quarry Trail	<i>Carduus nutans</i>	musk thistle	1	4	No	4633460.752	520695.087
			3	3	No	4630958.855	522830.516
			2	3	No	4630509.873	521766.156
East Red Hill drainage	<i>Cirsium arvense</i>	Canada thistle	3	3	No	4630434.047	521812.98
			3	3	No	4630446.217	521772.917
			3	3	No	4630668.515	521770.844
	<i>Bromus tectorum</i>	cheatgrass	3	3	No	4630673.695	521715.646
			2	3	No	4630588.932	521760.043
			2	2	No	4630629.949	521767.042
	<i>Centaurea maculosa</i>	spotted knapweed	2	2	No	4630629.949	521767.042
			1	3	No	4630345.961	521762.883

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Fossil Butte NM, July 24–28, 2010, cont.

Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing	Easting
East Red Hill drainage	<i>Melilotus officinalis</i>	yellow sweetclover	1	3	No	4630377.903	521784.55
			1	3	No	4630411.355	521795.958
			3	3	No	4630201.978	521661.395
			3	3	No	4630256.255	521688.536
			2	2	No	4630182.032	521654.202
			2	3	No	4630308.208	521710.162
Fossil Butte east drainage	<i>Bromus tectorum</i>	cheatgrass	2	3	No	4630329.565	521731.482
			3	2	No	4632107.366	522071.77
			3	3	No	4632213.444	521602.672
			2	3	No	4632162.261	522366.788
			2	3	No	4632145.871	522329.46
			2	3	No	4632141.329	522306.34
			2	3	No	4632163.207	522289.818
			2	3	No	4632087.507	522207.229
			2	2	No	4632430	521522.492
	<i>Cardaria chalepensis</i>	hoary cress/whitetop	2	3	No	4632187.144	522532.619
	<i>Carduus nutans</i>	musk thistle	2	3	No	4632170.888	522440.432
	<i>Cirsium arvense</i>	Canada thistle	2	3	No	4631289.67	520261.888
Fossil Butte south drainage	<i>Cirsium vulgare</i>	bull thistle	1	3	No	4635420.678	518462.745
	<i>Cirsium arvense</i>	Canada thistle	1	3	No	4635431.755	518469.505
			3	2	No	4635267.803	518392.256
			2	3	No	4635343.52	518436.227
Fossil Lake Trail			2	3	No	4635290.897	518394.553
	<i>Alopecurus arundinaceus</i>	creeping foxtail	1	5	No	4635047.287	518290.684
			1	5	No	4635025.565	518321.671
			2	4	No	4635417.065	518459.881
Fossil Butte north drainage			2	2	No	4635398.818	518452.577
	<i>Bromus tectorum</i>	cheatgrass	1	2	No	4635133.701	518793.151

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Fossil Butte NM, July 24–28, 2010, cont.						
Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing Easting
Fossil Lake Trail	<i>Bromus tectorum</i>	cheatgrass	3	3	No	4635166.555 518832.933
			3	2	No	4635381.504 518436.666
			2	2	No	4635011.132 518226.571
	<i>Elymus repens</i>	quackgrass	1	5	No	4635008.381 518422.215
			1	5	No	4635163.776 518726.393
			1	3	No	4635381.222 518478.774
			3	5	No	4635002.301 518331.098
			2	4	No	4635340.128 518842.07
Main Park Road	<i>Melilotus officinalis</i>	yellow sweetclover	1	3	No	4635436.61 518565.433
	<i>Hyoscyamus niger</i>	black henbane	1	3	No	4635318.616 518195.793
			1	3	No	4635933.145 517897.153
	<i>Cirsium vulgare</i>	bull thistle	1	5	No	4633856.043 518027.739
	<i>Cirsium arvense</i>	Canada thistle	1	5	No	4630774.028 519194.181
			1	5	No	4630609.381 519321.017
			1	5	No	4632220.602 518563.744
			1	5	No	4632648.419 518526.678
			1	5	No	4634222.524 517984.945
			1	3	No	4637094.89 518398.155
			1	3	No	4637424.13 518249.947
			2	3	No	4630919.695 519134.174
			2	4	No	4630562.282 519373.242
			2	4	No	4630481.322 519474.065
			2	5	No	4630227.821 519743.041
			2	3	No	4634061.682 517964.328
	<i>Alopecurus arundinaceus</i>	creeping foxtail	1	5	No	4630625.724 519304.234
			1	5	No	4631754.588 518871.83
			1	3	No	4638247.577 518586.288
			2	3	No	4638228.614 518292.725

Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing	Easting
Main Park Road	<i>Alopecurus arundinaceus</i>	creeping foxtail	2	2	No	4638296.418	518938.365
			2	2	No	4638301.873	518859.368
	<i>Bromus tectorum</i>	cheatgrass	1	1	No	4632081.441	518602.236
			1	3	No	4634412.695	518017.572
			5	3	No	4635864.636	518048.306
			3	4	No	4636574.547	518623.538
			3	3	No	4636783.897	518538.305
			3	3	No	4636525.259	518654.821
			3	2	No	4635267.602	518207.86
			3	3	No	4635338.248	518185.908
			3	2	No	4635445.89	518183.47
			3	2	No	4635525.24	518146.823
			3	3	No	4635808.42	517695.101
			3	3	No	4635889.62	517824.802
			3	2	No	4635947.902	517912.861
			3	2	No	4636066.88	518325.146
			3	2	No	4636096.326	518370.768
			3	1	No	4636272.948	518467.479
			3	2	No	4636400.735	518624.147
			3	3	No	4636434.057	518643.824
			3	2	No	4637334.055	518282.516
			3	2	No	4637372.016	518268.51
			3	2	No	4637422.591	518246.797
			3	3	No	4637504.859	518184.007
			3	3	No	4637580.056	518117.186
			3	2	No	4637678.643	518081.054
			3	2	No	4637934.247	518061.985
			3	2	No	4638230.818	518548.062
			3	2	No	4638278.037	518682.436
			3	1	No	4638309.732	518841.436

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Fossil Butte NM, July 24–28, 2010, cont.

Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing	Easting
Main Park Road	<i>Bromus tectorum</i>	cheatgrass	3	2	No	4638379.776	518911.572
			3	2	No	4637470.104	518218.514
			3	2	No	4637062.938	518404.35
			3	2	No	4636972.63	518435.261
			3	2	No	4635930.869	517896.629
			3	2	No	4635859.316	517755.218
			3	3	No	4635744.627	518296.014
			3	3	No	4635710.633	518216.047
			3	3	No	4635519.849	518151.163
			3	3	No	4635431.453	518190.228
			3	2	No	4635270.192	518212.377
			3	2	No	4634893.923	518164.229
			3	2	No	4634840.453	518139.975
			3	2	No	4634806.845	518116.642
			3	2	No	4634301.296	517979.35
			3	3	No	4633619.585	518119.322
			3	2	No	4633590.644	518138.35
			3	2	No	4633249.061	518319.642
			3	2	No	4633210.213	518330.646
			4	2	No	4635302.824	518207.702
			4	2	No	4635695.432	518175.478
			4	3	No	4635724.334	518245.607
			4	3	No	4635777.655	518266.344
			4	3	No	4635790.794	518158.32
			4	3	No	4635847.051	517904.008
			4	3	No	4635826.231	517823.638
			4	3	No	4635813.37	517751.594
			4	2	No	4635979.818	517994.32

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Fossil Butte NM, July 24–28, 2010, cont.

Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing	Easting
Main Park Road	<i>Bromus tectorum</i>	cheatgrass	4	2	No	4636000.095	518101.729
			4	2	No	4636016.53	518200.926
			4	2	No	4636035.123	518269.929
			4	2	No	4636333.72	518532.36
			2	2	No	4636843.149	518501.602
			2	4	No	4636893.989	518472.764
			2	5	No	4636756.17	518561.438
			2	2	No	4631339.385	518991.764
			2	2	No	4631744.785	518875.94
			2	2	No	4633737.968	518078.981
			2	2	No	4633797.054	518057.746
			2	3	No	4633828.221	518044.215
			2	5	No	4634077.022	517976.226
			2	3	No	4634780.065	518089.298
			2	1	No	4632245.089	518543.649
			2	3	No	4635028.295	518172.008
			2	2	No	4635222.994	518203.018
			2	3	No	4635598.059	518116.969
			2	2	No	4635638.574	518114.218
			2	3	No	4635876.117	517795.285
			2	3	No	4635905.184	517851.261
			2	3	No	4635925.257	517884.074
			2	3	No	4636230.425	518448.762
			2	2	No	4636369.364	518593.442
			2	3	No	4637918.182	518059.827
			2	2	No	4638009.588	518068.912
			2	1	No	4638231.2	518318.264
			2	2	No	4636917.273	518459.832

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Fossil Butte NM, July 24–28, 2010, cont.

Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing	Easting
Main Park Road	<i>Bromus tectorum</i>	cheatgrass	2	3	No	4636301.14	518490.257
			2	3	No	4636127.339	518398.247
			2	2	No	4635882.64	517805.902
			2	2	No	4635810.131	517710.791
			2	2	No	4635837.134	517876.285
			2	3	No	4635864.629	517988.516
			2	1	No	4635200.85	518211.444
			2	3	No	4633950.015	517965.974
			2	2	No	4633650.139	518103.681
			2	3	No	4633274.722	518316.357
			2	2	No	4633041.689	518413.374
			2	5	No	4633873.893	518016.192
			1	3	No	4632058.063	518617.641
	<i>Bromus japonicus</i>	Japanese brome	3	2	No	4634163.04	517980.607
			3	4	No	4634269.067	517989.265
			2	2	No	4631256.463	519022.88
			2	4	No	4631791.833	518845.093
			2	2	No	4633091.324	518408.381
			2	2	No	4633722.871	518084.387
			2	3	No	4633797.396	518058.344
			2	5	No	4634024.595	517973.761
			2	3	No	4634998.771	518214.988
			1	5	No	4632066.383	518616.407
			1	5	No	4632262.014	518551.331
			1	5	No	4632336.742	518533.843
			1	5	No	4633192.472	518358.72
<i>Carduus nutans</i>	musk thistle		1	5	No	4633306.199	518331.652
			1	5	No	4633698.379	518093.038
			1	2	No	4635494.583	518160.721
			1	2	No	4635494.583	518160.721

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Fossil Butte NM, July 24–28, 2010, cont.

Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing	Easting
Main Park Road	<i>Carduus nutans</i>	musk thistle	1	3	No	4638213.841	518450.203
			1	3	No	4637446.119	518234.982
			1	3	No	4633858.675	518015.729
			1	2	No	4633545.498	518175.806
			3	2	No	4635991.977	518066.074
			2	2	No	4635046.036	518162.949
			1	5	No	4637160.02	518411.412
			1	3	No	4635321.195	518195.586
<i>Elymus repens</i>	quackgrass		1	3	No	4635419.321	518181.477
			1	3	No	4635429.834	518186.018
			1	3	No	4635928.868	517890.638
			5	4	No	4630976.675	519115.371
			5	4	No	4632112.412	518597.56
			5	4	No	4632649.41	518529.54
			5	4	No	4633029.087	518426.944
			5	4	No	4633471.467	518231.929
			5	4	No	4633863.802	518023.851
			5	4	No	4634320.267	517991.06
			3	3	No	4636800.027	518534.593
			3	2	No	4631293.836	519006.951
			3	3	No	4630710.631	519228.12
			3	4	No	4630637.926	519290.393
			3	4	No	4635000.838	518218.605
			3	2	No	4635067.743	518155.768
			3	2	No	4635230.294	518204.382
			3	2	No	4635519.334	518149.295
			3	2	No	4635609.489	518113.99
			3	2	No	4635962.069	517937.734
			3	3	No	4635970.555	517986.069

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Fossil Butte NM, July 24–28, 2010, cont.

Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing	Easting
Main Park Road	<i>Elymus repens</i>	quackgrass	3	3	No	4636009.76	518164.095
			3	2	No	4638193.839	518090.435
			3	2	No	4637241.637	518343.823
			3	2	No	4637191.926	518392.173
			3	2	No	4635988.317	518082.955
			3	3	No	4635598.994	518118.311
			3	3	No	4635527.98	518147.241
			3	2	No	4634838.578	518139.352
			4	4	No	4636549.423	518639.166
			4	4	No	4631521.344	518868.767
			4	3	No	4630791.699	519186.952
			4	5	No	4630497.64	519453.026
			4	4	No	4630390.408	519587.777
			4	4	No	4630274.887	519726.45
			4	4	No	4630411.953	519540.506
			4	4	No	4630532.093	519392.568
			4	4	No	4630813.187	519162.092
			4	4	No	4631037.239	519084.761
			4	4	No	4631388.965	518957.013
			4	4	No	4631571.055	518813.133
			4	5	No	4631736.333	518877.598
			4	4	No	4631888.873	518712.842
			4	2	No	4635979.625	518049.215
			2	4	No	4636810.545	518523.69
			2	4	No	4636673.339	518604.152
			2	3	No	4635177.082	518188.244
			2	2	No	4635256.053	518206.877
			2	2	No	4635452.235	518180.248

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Fossil Butte NM, July 24–28, 2010, cont.

Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing	Easting
Main Park Road	<i>Elymus repens</i>	quackgrass	2	2	No	4635471.529	518171.781
			2	2	No	4635492.629	518161.57
			2	3	No	4635777.897	518236.038
			2	3	No	4636084.94	518353.317
			2	3	No	4637075.825	518401.455
			2	3	No	4637155.032	518403.771
			2	3	No	4637222.243	518353.773
			2	3	No	4637495.967	518191.83
			2	3	No	4637731.864	518058.802
			2	2	No	4638232.797	518210.744
			2	3	No	4638225.233	518182.12
			2	3	No	4638216.922	518131.902
			2	3	No	4638209.987	518107.625
			2	3	No	4638139.241	518102.715
			2	3	No	4638026.649	518073.462
			2	3	No	4636010.025	518178.894
			2	2	No	4634981.103	518216.611
			2	3	No	4634582.756	518061.051
			1	5	No	4636766.05	518551.448
			3	2	No	4632309.841	518540.326
<i>Bromus inermis</i>	smooth brome		2	4	No	4636804.312	518527.565
			2	3	No	4636865.429	518492.045
			1	5	No	4636670.997	518600.268
			1	5	No	4631904.678	518695.925
			1	5	No	4633433.933	518257.639
			1	3	No	4635022.838	518174.248
			1	3	No	4635321.258	518196.16
			1	3	No	4635588.896	518119.528
<i>Melilotus officinalis</i>	yellow sweetclover		1	3	No	4635977.49	518040.399

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Fossil Butte NM, July 24–28, 2010, cont.

Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing	Easting
Main Park Road	<i>Melilotus officinalis</i>	yellow sweetclover	1	3	No	4636005.903	518138.017
			1	3	No	4637344.777	518277.763
			1	3	No	4638223.863	518172.636
			1	3	No	4637427.582	518247.019
			1	3	No	4637360.435	518273.819
			1	2	No	4637265.786	518326.839
			1	3	No	4634662.614	518062.003
			1	3	No	4634485.278	518038.612
			1	3	No	4633776.812	518054.288
			1	3	No	4633765.012	518061.453
			1	3	No	4632989.519	518426.85
			3	3	No	4636689.82	518596.183
			3	2	No	4634065.389	517975.608
			3	2	No	4635997.906	518114.275
			2	2	No	4636707.3	518584.255
			2	5	No	4633676.496	518100.411
			2	2	No	4633750.697	518075.073
			2	2	No	4634559.407	518059.095
			2	3	No	4635381.314	518166.857
			2	3	No	4638221.085	518154.933
			2	3	No	4637372.505	518271.48
			2	2	No	4636004.951	518148.761
			2	2	No	4635975.471	518036.725
			2	2	No	4635970.564	518010.641
			2	3	No	4635812.15	518137.615
			2	3	No	4634536.213	518054.871
			2	2	No	4634505.117	518044.911
			2	2	No	4634355.993	518001.373

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Fossil Butte NM, July 24–28, 2010, cont.

Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing	Easting
Matate drainage	<i>Tragopogon dubius</i>	yellow salsify	1	3	Yes	4630299.586	520142.497
	<i>Melilotus officinalis</i>	yellow sweetclover	1	3	No	4630216.66	519980.405
			1	3	No	4630221.415	519997.385
Millet Canyon	<i>Cirsium vulgare</i>	bull thistle	1	5	No	4636732.938	517762.873
	<i>Cirsium arvense</i>	Canada thistle	1	5	No	4636636.428	517674.989
			2	3	No	4636387.41	517437.686
			2	4	No	4636735.652	517769.023
	<i>Alopecurus arundinaceus</i>	creeping foxtail	1	5	No	4636706.013	517740.327
	<i>Bromus tectorum</i>	cheatgrass	3	2	No	4636692.17	517727.85
Moose Bones Canyon			4	3	No	4636756.821	517819.912
	<i>Carduus nutans</i>	musk thistle	2	3	No	4636359.735	517425.274
	<i>Elymus repens</i>	quackgrass	3	3	No	4636445.594	517463.337
			3	5	No	4636718.244	517750.071
			3	3	No	4636771.92	517852.271
			3	3	No	4636911.228	518035.692
			2	3	No	4636806.112	517921.715
	<i>Cirsium vulgare</i>	bull thistle	1	5	No	4634941.401	520474.644
			2	5	No	4634851.883	520285.231
	<i>Cirsium arvense</i>	Canada thistle	1	5	No	4634875.481	519716.517
			3	5	No	4634945.348	520492.004
			4	3	No	4634845.076	520258.398
			4	3	No	4634819.631	520011.435
			2	5	No	4634852.982	520302.861
	<i>Alopecurus arundinaceus</i>	creeping foxtail	1	5	No	4634887.3	520365.644
			1	5	No	4634901.074	520391.104
			1	5	No	4635141.155	520817.853
	<i>Bromus tectorum</i>	cheatgrass	1	5	No	4634849.865	520313.849
			2	5	No	4634821.918	519665.644

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Fossil Butte NM, July 24–28, 2010, cont.						
Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing Easting
Moose Bones Canyon	<i>Bromus tectorum</i>	cheatgrass	2	4	No	4634850.068 520073.615
			2	5	No	4634718.574 519765.932
	<i>Carduus nutans</i>	musk thistle	1	5	No	4634848.552 520072.476
			3	2	No	4634806.817 519635.102
	<i>Trifolium pratense/repens</i>	red clover	2	5	No	4634854.059 520316.95
Murder Hill Drainage	<i>Bromus inermis</i>	smooth brome	1	5	No	4634864.218 519960.832
			2	5	No	4634849.209 520235.565
			2	5	No	4634849.989 520288.708
	<i>Trifolium pratense/repens</i>	white clover	2	5	No	4634854.059 520316.95
	<i>Bromus tectorum</i>	cheatgrass	1	2	No	4636931.418 519104.475
North Dam Fork Chicken Creek	<i>Cirsium arvense</i>	Canada thistle	2	2	No	4636965.921 519107.048
			2	3	No	4636972.882 519094.234
	<i>Cirsium vulgare</i>	bull thistle	2	3	No	4633791.526 519527.626
	<i>Alopecurus arundinaceus</i>	creeping foxtail	3	2	No	4633921.08 519692.495
			3	2	No	4633420.764 519309.751
	<i>Carduus nutans</i>	musk thistle	1	2	No	4633487.298 519314.256
			1	3	No	4633078.753 519170.349
			1	3	No	4632976.231 519169.122
			1	3	No	4632870.924 519174.662
			2	3	No	4633891.195 519605.12
	<i>Carduus nutans</i>	musk thistle	2	2	No	4633768.402 519523.123
			2	2	No	4633451.756 519311.791
			2	2	No	4633381.103 519315.436
			2	2	No	4633344.629 519293.058
			2	2	No	4633191.427 519199.694
	<i>Carduus nutans</i>	musk thistle	2	3	No	4633031.581 519164.12
			2	3	No	4632485.308 519065.191
			1	3	No	4633075.116 519168.233
			3	1	No	4633061.015 519168.295

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Fossil Butte NM, July 24–28, 2010, cont.

Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing	Easting
North of E. Fork Chicken Creek	<i>Bromus tectorum</i>	cheatgrass	2	3	No	4633791.426	520303.432
			2	3	No	4633857.889	520248.535
Ruby Point Road	<i>Cirsium arvense</i>	Canada thistle	2	3	No	4637272.283	518318.913
	<i>Bromus tectorum</i>	cheatgrass	3	2	No	4637304.022	518297.445
	<i>Carduus nutans</i>	musk thistle	1	5	No	4636847.02	515961.109
	<i>Elymus repens</i>	quackgrass	1	5	No	4637201.85	517831.865
			1	5	No	4637012.387	516523.713
			3	5	No	4637222.014	517333.017
			3	2	No	4637291.137	518307.691
			2	5	No	4637192.765	518022.99
			2	5	No	4637192.924	517884.255
			2	3	No	4632268.657	519296.033
Sage Grouse Lek drainage	<i>Cirsium arvense</i>	Canada thistle	2	3	No	4632288.248	519312.344
	<i>Alopecurus arundinaceus</i>	creeping foxtail	1	1	No	4632058.406	519233.179
Smallpox Creek	<i>Hyoscyamus niger</i>	black henbane	1	5	No	4630272.12	519277.346
	<i>Cirsium arvense</i>	Canada thistle	3	5	No	4630297.346	519301.249
			3	5	No	4631206.89	518677.434
			2	5	No	4630477.488	519139.726
			2	5	No	4630893.143	518697.289
			2	5	No	4631439.412	518512.975
			2	3	No	4630972.076	518647.08
	<i>Alopecurus arundinaceus</i>	creeping foxtail	1	5	No	4630370.389	519218.487
			1	5	No	4630739.183	518893.026
			1	5	No	4630821.552	518810.646
		1	5	No	4631324.735	518624.202	
		2	2	No	4630571.3	519003.47	
<i>Bromus tectorum</i>	cheatgrass	3	3	No	4630267.125	519278.593	
<i>Carduus nutans</i>	musk thistle	1	5	No	4630232.412	519241.436	
		2	2	No	4631091.213	518639.538	

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Fossil Butte NM, July 24–28, 2010, cont.						
Monitoring route	Scientific name	Species name	Infestation size class	Canopy cover class	Pulled?	Northing Easting
South Millet Canyon	<i>Hyoscyamus niger</i>	black henbane	2	5	No	4636333.149 517578.926
	<i>Cirsium vulgare</i>	bull thistle	1	5	No	4636343.642 517734.158
	<i>Cirsium arvense</i>	Canada thistle	3	3	No	4636321.648 517416.989
			2	3	No	4636419.895 517885.987
			2	2	No	4636345.664 517745.949
			2	4	No	4636342.71 517696.524
			2	5	No	4636334.182 517580.893
	<i>Alopecurus arundinaceus</i>	creeping foxtail	1	5	No	4636333.581 517570.27
			2	3	No	4636421.034 517892.059
			2	4	No	4636350.215 517760.707
	<i>Carduus nutans</i>	musk thistle	4	2	No	4636403.621 517804.442
			2	3	No	4636426.291 517876.882
			2	2	No	4636325.787 517595.912
	<i>Elymus repens</i>	quackgrass	1	5	No	4636436.19 518001.893
			1	2	No	4636343.065 517729.286
			3	4	No	4636417.726 517848.218
			2	2	No	4636462.693 518147.927
			2	3	No	4636433.231 517936.22
			2	4	No	4636361.177 517769.059
			2	3	No	4636342.975 517689.965
			2	4	No	4636333.423 517575.922
	<i>Carduus nutans</i>	musk thistle	1	3	No	4636467.752 519355.777
	<i>Bromus tectorum</i>	cheatgrass	3	2	No	4631689.814 518989.633
			3	2	No	4631665.346 518966.224
West Red Hill drainage	<i>Melilotus officinalis</i>	yellow sweetclover	2	5	No	4630541.212 521044.617

Appendix C. Invasive Exotic Plant Percent Cover Detected by Monitoring Quadrats at Fossil Butte NM, July 24–28, 2010

Route	Transect	Species	Common name	Mean cover	Easting	Northing
Cundick Ridge Road	90	<i>Taraxacum officinale</i>	common dandelion	0.166667	518973.7	4635779
Fossil Lake Trail	97	<i>Poa pratensis</i> <i>Taraxacum officinale</i>	Kentucky bluegrass common dandelion	0.666667 0.166667	518750.5 518750.5	4635369 4635369
Main Park Road	60	<i>Agropyron cristatum</i> <i>Alyssum desertorum</i> <i>Elymus repens</i>	crested wheatgrass desert madwort quackgrass	1.5 0.166667 4.333333	519579.1 519579.1 519579.1	4630397 4630397 4630397
	61	<i>Alyssum desertorum</i> <i>Bromus inermis</i> <i>Bromus japonicus</i> <i>Bromus tectorum</i> <i>Taraxacum officinale</i>	desert madwort smooth brome Japanese chess cheatgrass common dandelion	0.5 1.333333 0.166667 0.166667 0.166667	519203.8 519203.8 519203.8 519203.8 519203.8	4630730 4630730 4630730 4630730 4630730
	62	<i>Alyssum desertorum</i> <i>Bromus inermis</i> <i>Bromus tectorum</i> <i>Elymus repens</i> <i>Taraxacum officinale</i>	desert madwort smooth brome cheatgrass quackgrass common dandelion	0.5 0.166667 0.166667 4.666667 0.333333	519042.6 519042.6 519042.6 519042.6 519042.6	4631196 4631196 4631196 4631196 4631196
	63	<i>Alyssum desertorum</i> <i>Taraxacum officinale</i>	desert madwort common dandelion	0.333333 0.333333	518806.8 518806.8	4631633 4631633
	67	<i>Alyssum desertorum</i> <i>Elymus repens</i> <i>Poa pratensis</i>	desert madwort quackgrass Kentucky bluegrass	0.5 1 0.666667	518258.6 518258.6 518258.6	4633414 4633414 4633414
	68	<i>Alyssum desertorum</i> <i>Descurainia sophia</i> <i>Poa pratensis</i>	desert madwort flixweed Kentucky bluegrass	0.5 0.333333 0.333333	517989 517989 517989	4634342 4634342 4634342
	70	<i>Bromus tectorum</i>	cheatgrass	1.666667	518213.3	4635282
	71	<i>Bromus tectorum</i> <i>Descurainia sophia</i>	cheatgrass flixweed	0.166667 0.166667	518205.4 518205.4	4635710 4635710
	72	<i>Bromus tectorum</i>	cheatgrass	1.666667	517943.3	4635859
	73	<i>Bromus tectorum</i>	cheatgrass	0.166667	517903.6	4635939

Appendix C. Invasive Exotic Plant Percent Cover Detected by Monitoring Quadrats at Fossil Butte NM, July 24–28, 2010.

Route	Transect	Species	Common name	Mean cover	Easting	Northing
Main Park Road	74	<i>Bromus tectorum</i>	cheatgrass	0.333333	518365.6	4636089
	75	<i>Taraxacum officinale</i>	common dandelion	0.333333	518649.2	4636465
	76	<i>Bromus tectorum</i>	cheatgrass	0.666667	518462.3	4636917
		<i>Taraxacum officinale</i>	common dandelion	0.333333	518462.3	4636917
		<i>Tragopogon dubius</i>	yellow salsify	0.166667	518462.3	4636917
	79	<i>Bromus inermis</i>	smooth brome	0.333333	518190.2	4638230
	80	<i>Bromus tectorum</i>	cheatgrass	3.333333	518657.3	4638271
	81	<i>Bromus japonicus</i>	Japanese chess	0.166667	518029.6	4633854
		<i>Elymus repens</i>	quackgrass	4.166667	518029.6	4633854
		<i>Poa pratensis</i>	Kentucky bluegrass	4	518029.6	4633854
Millet Canyon	52	<i>Elymus repens</i>	quackgrass	0.333333	517507.7	4636510
		<i>Poa pratensis</i>	Kentucky bluegrass	0.166667	517507.7	4636510
Moose Bones Canyon	26	<i>Poa pratensis</i>	Kentucky bluegrass	2	519988.9	4634853
		<i>Taraxacum officinale</i>	common dandelion	1.666667	519988.9	4634853
	27	<i>Cirsium arvense</i>	Canada thistle	2	520473.3	4634944
North Dam Fork Chicken Creek	32	<i>Alopecurus arundinaceus</i>	creeping foxtail	23.333333	519602.2	4633885
Ruby Point Road	82	<i>Taraxacum officinale</i>	common dandelion	0.166667	518036.2	4637184
	84	<i>Taraxacum officinale</i>	common dandelion	0.166667	517082	4637213
	85	<i>Taraxacum officinale</i>	common dandelion	0.166667	516676.3	4636994
		<i>Tragopogon dubius</i>	yellow salsify	0.166667	516676.3	4636994
Smallpox Creek	55	<i>Poa pratensis</i>	Kentucky bluegrass	0.666667	518684.6	4631227
	57	<i>Alyssum desertorum</i>	desert madwort	0.5	519141	4630480
		<i>Cirsium arvense</i>	Canada thistle	0.666667	519141	4630480
		<i>Poa pratensis</i>	Kentucky bluegrass	0.166667	519141	4630480
South Millet Canyon	24	<i>Taraxacum officinale</i>	common dandelion	1.5	517713.1	4636348
	25	<i>Elymus repens</i>	quackgrass	2.666667	518178.3	4636466

Bold indicates Priority 1 species.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
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