



Invasive Exotic Plant Monitoring at Fossil Butte National Monument

2008 Pilot Field Season

Natural Resource Technical Report NPS/NCPN/NRTR—2009/234



ON THE COVER

Fossil Butte National Monument. NPS photo.

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Acronyms

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

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 the pilot field season at Fossil Butte National Monument (FOBU) in 2008, when methods were tested at FOBU and Golden Spike National Historic Site (GOSP). These methods included (1) rapid-monitoring routes that focused on locating the highest-priority IEPs, (2) monitoring plots that provided more quantitative information on a wider range of IEPs, and (3) extra-area surveys that focused on an area of immediate management concern. On July 14–15, 2008, 23 IEP species were detected on monitoring routes, plots, and extra-area surveys of two burned areas at FOBU. IEPs were widespread along the Main Park Road at FOBU, but much less prevalent elsewhere. Generally, the further a route was from areas of high visitation, the fewer IEPs detected. Many IEPs were present in small, localized invasions that have a promising chance of successful management control and eradication. Based on the results from this season, the NCPN will make two changes to the protocol in order to make quantitative collection of plot data more efficient and enable field crews to cover more area at a given park. In 2009, the NCPN will return to FOBU to sample the remaining monitoring routes. In addition, the network will test the revised protocols in other network parks with different plant communities than those in FOBU and GOSP.

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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, managers of Northern Colorado Plateau Network (NCPN) parks identified invasive exotic plants (IEPs) as a high-priority vital sign for long-term monitoring (O'Dell et al. 2005).

IEPs are a subset of exotic plants “whose introduction does or is likely to cause economic or environmental harm or harm to human health” (Executive Order 13112). With the aim of facilitating strategic control approaches, 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 pilot field testing of the IEP protocol that was conducted at Fossil Butte National Monument (FOBU) in 2008. The invasive protocol will be adjusted based on this pilot work at FOBU and additional work completed at Golden Spike National Historic Site.

2 Methods

Field work followed the invasive exotic plant monitoring protocol developed by the NCPN (in prep.), 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 to find 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 will capture the greatest amount of information (i.e., benefit) with the least amount of time and effort (i.e., cost).

The first step in the monitoring process was to develop a list of target invasive plants for the park (see below). Next, we established a series of co-located monitoring routes and plots along all roads, major drainages, and trails in the park. The plots, 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

To develop a list of high-priority target IEPs for FOBU (see Appendix A), we worked with park staff and county weed managers, and reviewed past park literature and state and county weed lists. Our high-priority target 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 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.

2.2 Monitoring routes

2.2.1 Survey parameters

We surveyed monitoring routes at FOBU using the parameters described in the following sections.

2.2.1.1 Minimum Detection Target Size (MDTS)

The minimum detection target size (MDTS) represented the patch size that was 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 established an MDTS of 40 m² (0.01 acres or approximately 20 × 20 ft) for all IEPs. Use of the MDTS was necessary because field technicians were 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 *Elaeagnus angustifolia* (Russian olive) and *Tamarix ramosissima* (saltcedar), is possible due to their large size, single plants of other species, such as *Convolvulus arvensis* (field bindweed) or *Potentilla recta* (sulfur cinquefoil), are nearly impossible to detect in most field conditions.

2.2.1.2 Effective Detection Distance (EDD)

The effective detection distance (EDD) was the maximum distance from which a searcher could consistently detect (i.e., see and recognize) the MDTS of the least-visible targeted species with at least 90% detection efficiency. Crew members calibrated themselves by walking away from a targeted patch size of the least-visible species and determining the maximum distance from which they could consistently see and recognize the patch with complete confidence. The distance was measured either by pacing or using a laser rangefinder. The EDD for FOBU was between 10 and 20 m, depending on vegetation.

2.2.1.3 Effective Detection Swath Width (EDSW)

Effective detection swath width (EDSW) was 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 2.2.1.3). 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 20 to 40 m at FOBU.

2.2.1.4 Patch Separation Resolution (PSR)

We defined patch separation resolution (PSR) as the minimum distance between plants that must

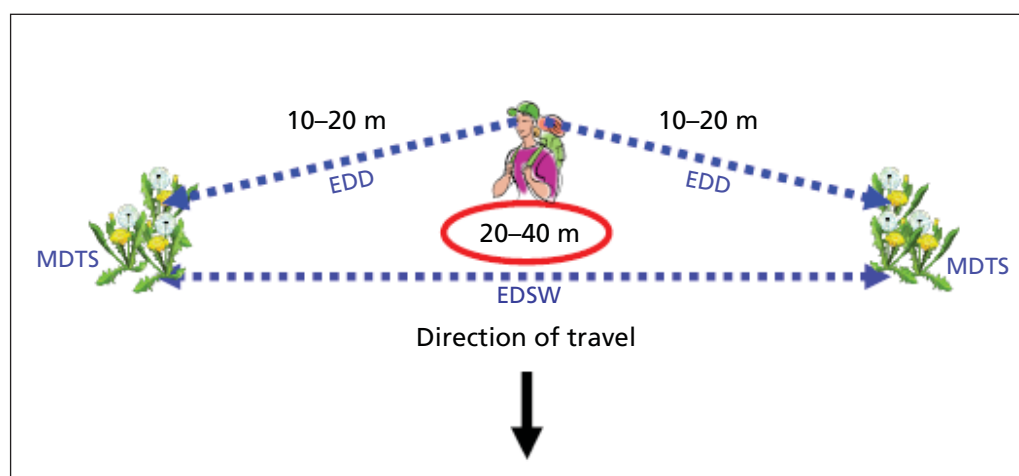


Figure 2.2.1.3. The effective detection distance (EDD) for a minimum detection target size (MDTS) at Fossil Butte NM was 10–20 meters, making the effective detection swath width (EDSW) a distance of 20–40 meters (from Andersen and Dewey 2007).

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 considered plants separated by less than the PSR to be a single patch or infestation. The PSR was 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 was 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.

2.2.2 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 a total coverage of 20–40 m EDSW on each side of the road (40–80 m total for both sides) in most cases. For secondary roads, single-track trails and drainages, we walked the center of the trail or drainage in only one direction, for a total coverage of 20–40 m EDSW.

While walking, we searched for species on the target IEP list 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 20–40 m—the length of one EDSW—and visually scanned the area in all directions. As monitoring routes were

traversed, locations of all target species were documented using global positioning system (GPS) units with at least 5-meter accuracy.

Only species that were designated as Priority 1 were consistently recorded during monitoring routes, with the exception of cheatgrass (*Bromus tectorum*), which park staff requested we map along the Main Park Road and in the two burned areas surveyed with extra-area survey techniques. Survey crew members were given the latitude 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 a separate point.

Infestation size class was estimated as follows (see Table 3.3-3):

- 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. Canopy cover of a patch was recorded using the following classes (see Appendix B):

- 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: slope, aspect, 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).

2.2.3 Analysis

We calculated the mean number of infestations per 100 m for monitoring routes. Percent cover estimates were generated from the monitoring-plot data (see below).

2.3 Monitoring plots

Our methods for sampling the monitoring plots were based on Stohlgren and others (2005). We established plots with three 1-m² vegetation quadrats every 1 km along all routes except the Chicken Creek Nature Trail, where plots were established every 400 m.

2.3.1 Plot establishment

We centered plots 5 m away from the edge of a road, trail, or drainage, on the same side as the route that was being walked. For routes along roads, where observers walked on one side on the way out and returned on the opposite side, we established plots only on the way out. Each plot was a 177-m² circle containing three nested quadrats of 1 m². We recorded a GPS location at the center of each plot and established three 7.5-m transects radiating out from the center on 30°, 150°, and 270° azimuths. We flagged transects at the 7.5-m mark to delineate the perimeter of the plot. A

1-m² sampling frame was used to sample cover of vegetation and soil surface features between 4.5 and 5.5 m along each of the three transects. The 1-m² quadrat frame was placed on the right side of the transect line as viewed from plot center.

2.3.2 Data collection methods

In the monitoring plots, all IEP species observed that were on the target list were recorded. For each quadrat, we recorded percent cover of dominant species with >5% cover and any exotic species using the following classes: <1, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11–25, 26–50, 51–75, or >75%. We also recorded percent cover to the nearest 10% of dominant soil surface features (dead wood, scat, fungus, lichen, litter/duff, live root/bole, mineral soil/sediment, moss, biological soil crust, road, rock, standing water/flooded, stream, or trash/junk). After completing the three quadrats, we conducted a walking search of the entire plot and recorded any new invasive species that were not found in the quadrats. We also recorded the following ancillary data for the plot: slope, aspect, diameter at breast height (dbh) of trees >10 cm dbh, a tally of trees <10 cm dbh, total tree canopy cover (estimated to nearest 10%), distance to stream or water, road, or crops within 100 m of the plot; and descriptions of disturbances.

2.4 Extra-area surveys

Two extra areas were searched using transects along straight parallel lines that followed a UTM northing or easting. To conduct these searches, the surveyor walked to a starting position on the edge of the intended search area corresponding to a convenient UTM value. The surveyor then used a compass to set a bearing and a horizon landmark to aim for while surveying the transect. The surveyor then walked the transect, searching for IEPs on either side of the transect center. When an IEP was found, the surveyor stood in the center of the patch to enter the necessary data. Transects were placed in parallel fashion one EDSW apart.

2.5 Analyses

We calculated the mean and standard error of percent cover by species for monitoring plots. For classes represented by a range of percent cover values (11–25, 26–50, 51–75, and >75% cover), midpoints were used (18, 38, 63, and 88%) when calculating the mean and standard error.

3 Results

3.1 Park target invasive exotic plant list

Twenty-two IEP species were identified as Priority 1 for the FOBU target IEP list (Appendix A). An additional 15 and 14 species were identified as Priority 2 and 3 species, respectively, for a total target list of 51 species. A total of 22 IEP species were recorded on monitoring routes, plots, and extra-area surveys (Table 3.1, Figure 3.1). Thirteen IEP species were recorded on monitoring routes and 11 in monitoring plots. Only one species, flixweed (*Descurainia sophia*), was recorded on both plots and routes. Four species were recorded during the extra-area searches. Of the 22 IEP species detected, 8 were Priority 1, 7 were Priority 2, and 7 were not identified as priority species (Table 3.1). We covered 282 hectares (696 acres) between the monitoring routes and the extra-area surveys, representing 8.5% of the entire park.

3.2 Monitoring routes

The survey crew walked a total of 34.7 km (21.6 miles) along seven monitoring routes. With the EDSW, this represents a total of 202 hectares (500 acres) surveyed. A total of 260 infestations were detected along monitoring routes, including eight Priority 1 species, two Priority 2 species, and three species not on the target list (Tables 3.2-1 and 3.2-2, Figures 3.2-1, 3.2-2, 3.2-3, 3.2-4, Appendix B). Quackgrass (*Elymus repens*), yellow sweetclover (*Melilotus officinalis*), cheatgrass, Canada thistle (*Cirsium arvense*), and flixweed were the IEPs most commonly detected. IEPs were most prevalent along the Main Park Road, which includes the area around the visitor center, which had more than double the number of detections per 100 m than any other monitoring route. Routes or sections of routes that were located away from areas of high visitation generally had lower numbers of IEP invasions. No IEPs were detected on Eagle Nest Point Road, and very few were detected on Ruby Point Road. Of the 260 infestations, 83% were classified as infestations in either the “1 to a few plants” (1) or “few plants to 40 m²” (2) size classes.

3.3 Monitoring plots

A total of 23 plots were sampled (Table 3.3, Figure 3.3, Appendix C). Two species, broadleaf plantain (*Plantago major*) and field pennycress (*Thlaspi arvense*), were only detected in the plot walk outside the nested quadrats. After further review, we are unsure of the identification of *P. major*, as it has not been detected in the park, but the native and morphologically similar Tweedy’s plantain (*Plantago tweedyi*) has been detected in the park. If this species is detected again in 2009, we will take steps to ensure positive identification.

The results presented here focus on cover in 1-m² quadrats. IEP species were present in 26% of the plots, with an average of 0.61 IEP species detected per plot. IEP cover across all 23 plots was estimated to be 1.1%. No Priority 1 species were detected in the monitoring plots. Several areas (Main Park Road, Bullpen Two-Track Road, Eagle Nest Point Road, Cundick Ridge Road, and Ruby Point Road) had no IEPs in plots; however, only a limited number of plots were established in these areas. Chicken Creek and Chicken Creek Nature Trail, areas of high visitation, had the most IEPs, with IEPs present in 42% and 60% of the plots, respectively. These two areas are also areas of heavy visitation. No species exceeded 1.07% cover along any given monitoring route. Kentucky bluegrass (*Poa pratensis*) was the most widespread IEP taxon, present in 17% of the plots and with a mean canopy cover of 0.4% across all plots (Table 3.3). No other species was found in more than two plots.

3.4 Extra-area searches

A total of 79 hectares (196 acres) were searched in two areas that had prescribed fires in 2005: the West Fork Unit (34 ha/83 ac) and Switchback Unit (46 ha/113 ac) (Figure 3.2-3, Table 3.4, Appendix D). The extra-area surveys entirely covered the two burn units. Thirty-seven (1.09/ha, 0.45/acre) and 34 (0.74/ha, 0.30/acre) IEP infestations were detected in the West Fork and Switchback units, respectively. Cheatgrass was the most prevalent species, representing 89% of the IEPs detected. Of the 71 infestations, 76% were classified as infestations in either the “1 to a few plants” (1) or “few plants to 40 m²” (2) size classes.

Table 3.1. List of invasive exotic plants recorded, Fossil Butte NM, July 14–15, 2008.

Scientific name	Common name	Method detected			Park priority
		Routes	Plots	Extra areas	
<i>Cardaria chalepensis</i>	lens-pod whitetop	X			1
<i>Carduus nutans</i>	musk thistle	X		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>Elymus repens</i>	quackgrass	X			1
<i>Hyoscyamus niger</i>	black henbane	X		X	1
<i>Melilotus officinalis</i>	yellow sweetclover	X			1
<i>Descurainia sophia</i>	flixweed	X	X	X	2
<i>Halogeton glomeratus</i>	halogeton		X		2
<i>Lepidium perfoliatum</i>	clasping pepperweed		X		2
<i>Phleum pratense</i>	timothy grass		X		2
<i>Salsola tragus</i>	Russian thistle	X			2
<i>Thlaspi arvense</i>	field pennycress		X		2
<i>Tragopogon dubius</i>	goatsbeard		X		2
<i>Bromus tectorum</i> *	cheatgrass	X		X	Not on list
<i>Medicago sativa</i>	alfalfa	X			Not on list
<i>Poa bulbosa</i>	bulbous bluegrass	X			Not on list
<i>Poa pratensis</i>	Kentucky bluegrass		X		Not on list
<i>Polygonum aviculare</i>	prostrate knotweed		X		Not on list
<i>Ranunculus testiculatus</i>	curveseed butterwort		X		Not on list
<i>Trifolium repens</i>	white clover		X		Not on list

**Bromus tectorum* was only regularly recorded along the Main Park Road and in the burn units covered by the extra-area surveys.

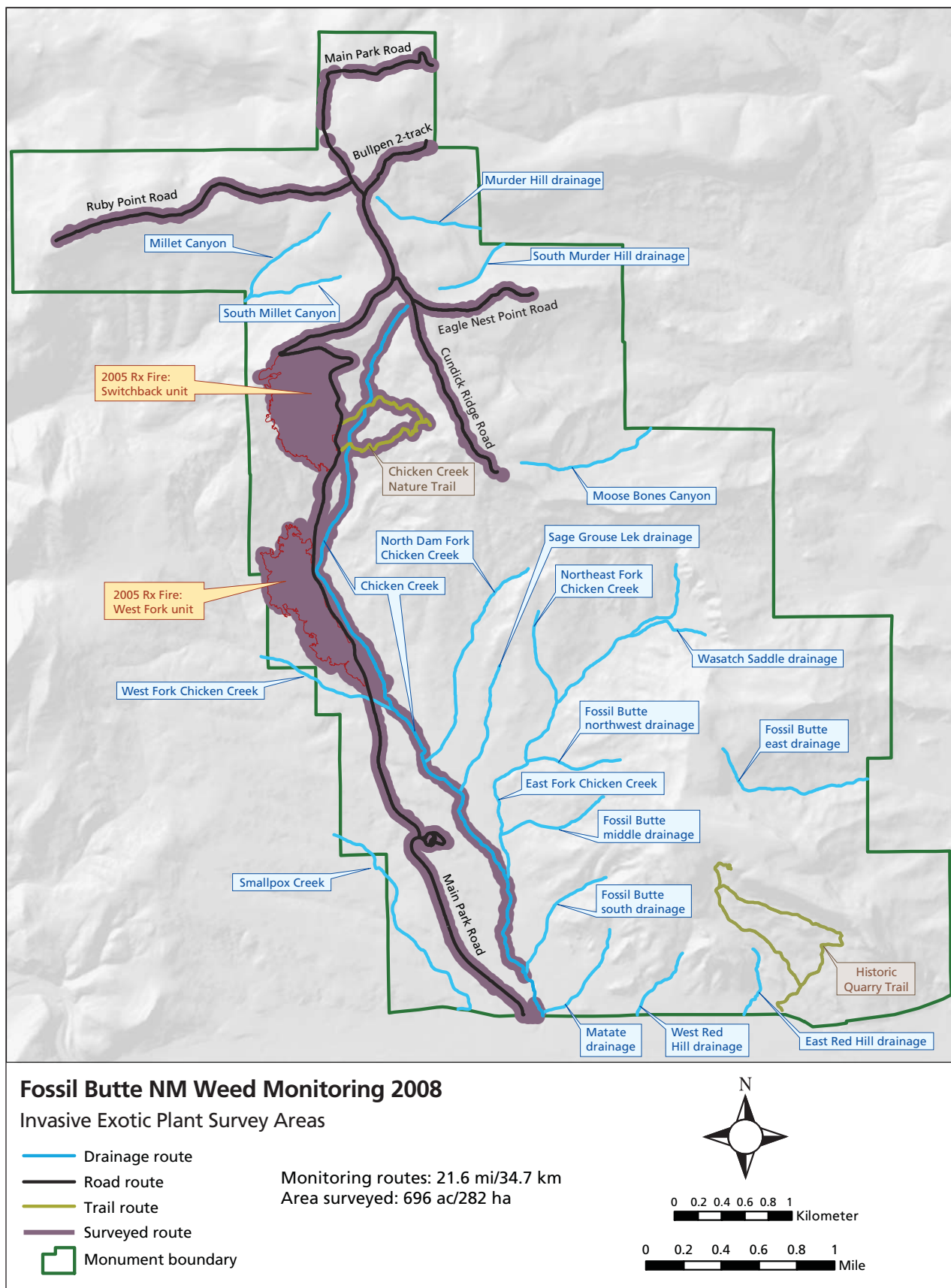


Figure 3.1. Overview of invasive plant monitoring routes and extra areas surveyed at Fossil Butte National Monument, July 14–15, 2008.

Table 3.2-1. Number of IEP infestations per route surveyed, Fossil Butte National Monument, July 14–15, 2008.

Route	Type of route	Length (m)	Infestations	Infestations/100 m
Chicken Creek	Riparian	7,200	14	0.19
Bullpen Two Track	Road	783	3	0.38
Cundick Ridge Road	Road	1,981	9	0.45
Eagle Nest Point Road	Road	1,134	0	0.00
Main Park Road	Road	18,793	223	1.19
Ruby Point Road	Road	2,740	2	0.07
Chicken Creek Nature Trail	Trail	2,118	9	0.42
	<i>All riparian</i>	<i>7,200</i>	<i>14</i>	<i>0.19</i>
	<i>All roads</i>	<i>25431</i>	<i>237</i>	<i>2.09</i>
	<i>All trails</i>	<i>2,118</i>	<i>9</i>	<i>0.42</i>
	All routes	34,749	260	0.75

Table 3.2-2. Species observed and size of infestation detected for Priority 1 species along monitoring routes, Fossil Butte National Monument, July 14–15, 2008.

Scientific name	Common name	Infestation size class Number of infestations					Total infestations
		1	2	3	4	5	
<i>Bromus tectorum</i> *	cheatgrass	19	14	10	1	0	44
<i>Cardaria chalapensis</i>	lens-podded whitetop	1	1	0	0	0	2
<i>Carduus nutans</i>	musk thistle	7	3	0	0	0	10
<i>Cirsium arvense</i>	Canada thistle	20	18	3	0	0	41
<i>Cirsium vulgare</i>	bull thistle	1	1	0	0	0	2
<i>Convolvulus arvensis</i>	field bindweed	0	4	0	0	0	4
<i>Descurainia sophia</i>	flixweed	20	9	8	2	0	39
<i>Elymus repens</i>	quackgrass	19	17	12	3	0	51
<i>Hyoscyamus niger</i>	black henbane	15	0	1	0	0	16
<i>Medicago sativa</i>	alfalfa	1	0	0	0	0	1
<i>Melilotus officianlis</i>	yellow sweetclover	38	7	3	0	0	48
<i>Poa bulbosa</i>	bulbous bluegrass	0	0	1	0	0	1
<i>Salsola tragus</i>	Russian thistle	0	1	0	0	0	1
All species		141	75	38	6	0	260

**Bromus tectorum* was only regularly recorded along the Main Park Road and in the burn units covered by the extra-area surveys.

Infestation size classes

- 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)
- 5) 1,000–2,000 m² (0.25–0.5 acre)

Fossil Butte NM **Weed Monitoring 2008** Area Overview

Species name, infestation size class

- Alfalfa (1)
- Black henbane (1)
- Black henbane (3)
- Bulbous bluegrass (3)
- Bull thistle (1)
- Bull thistle (2)
- Canada thistle (1)
- Canada thistle (2)
- Canada thistle (3)
- Cheatgrass (1)
- Cheatgrass (2)
- Cheatgrass (3)
- Cheatgrass (4)
- Cheatgrass (5)
- Field bindweed (2)
- Flixweed (1)
- Flixweed (2)
- Flixweed (3)
- Flixweed (4)
- Lens-podded whitetop (1)
- Lens-podded whitetop (2)
- Musk thistle (1)
- Musk thistle (2)
- Quackgrass (1)
- Quackgrass (2)
- Quackgrass (3)
- Quackgrass (4)
- Russian thistle (2)
- Yellow sweetclover (1)
- Yellow sweetclover (2)
- Yellow sweetclover (3)

● Burned area

■ Monument boundary

Infestation size classes

- (1) 1–a few plants
- (2) few plants–40 m²
- (3) 40–400 m²
- (4) 400–1,000 m²
- (5) 1,000–2,000 m²

Monitoring routes: 21.6 mi/34.7 km

Area surveyed: 696 ac/282 ha

Invasives: 332 infestations mapped

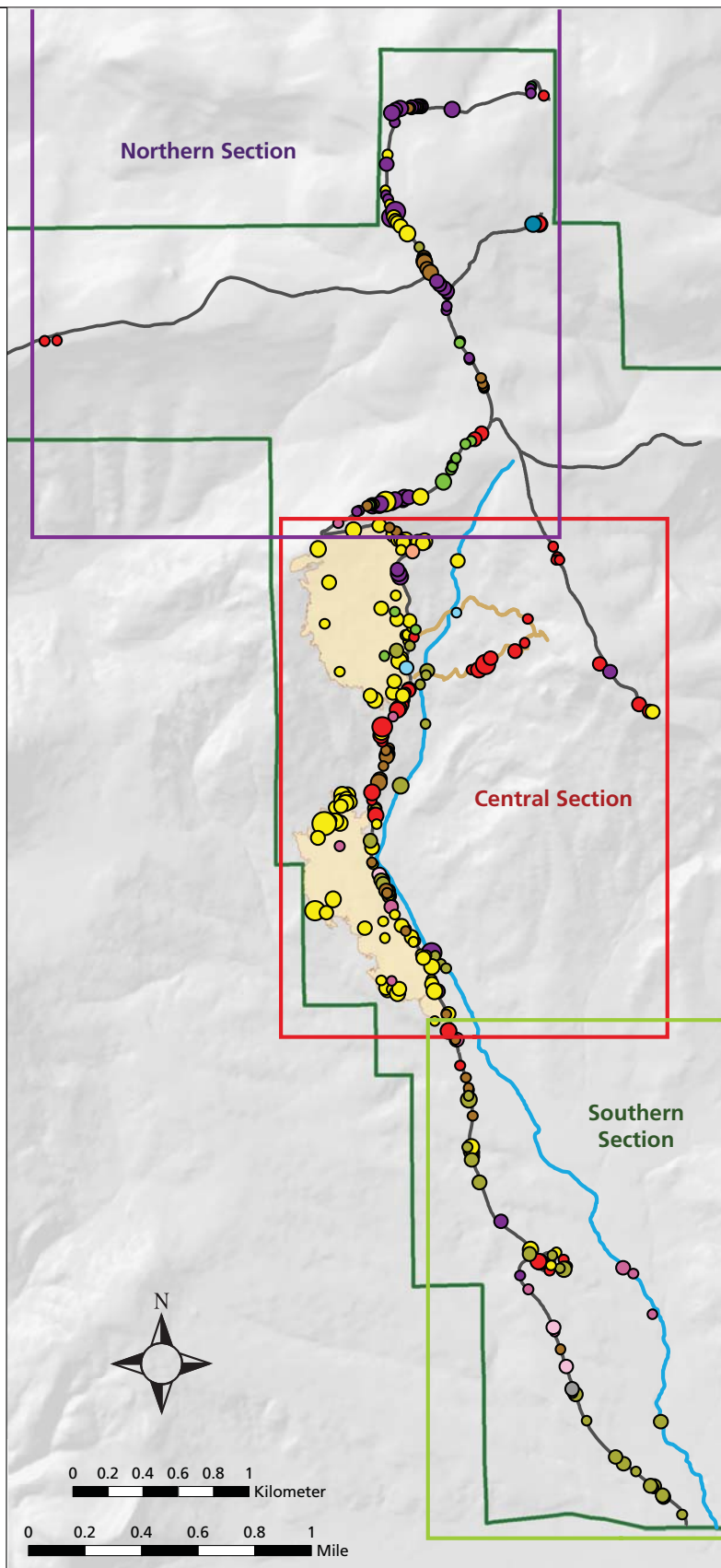


Figure 3.2-1. Invasive plants detected along monitoring routes, monitoring plots, and extra-area surveys at Fossil Butte National Monument, July 14–15, 2008.

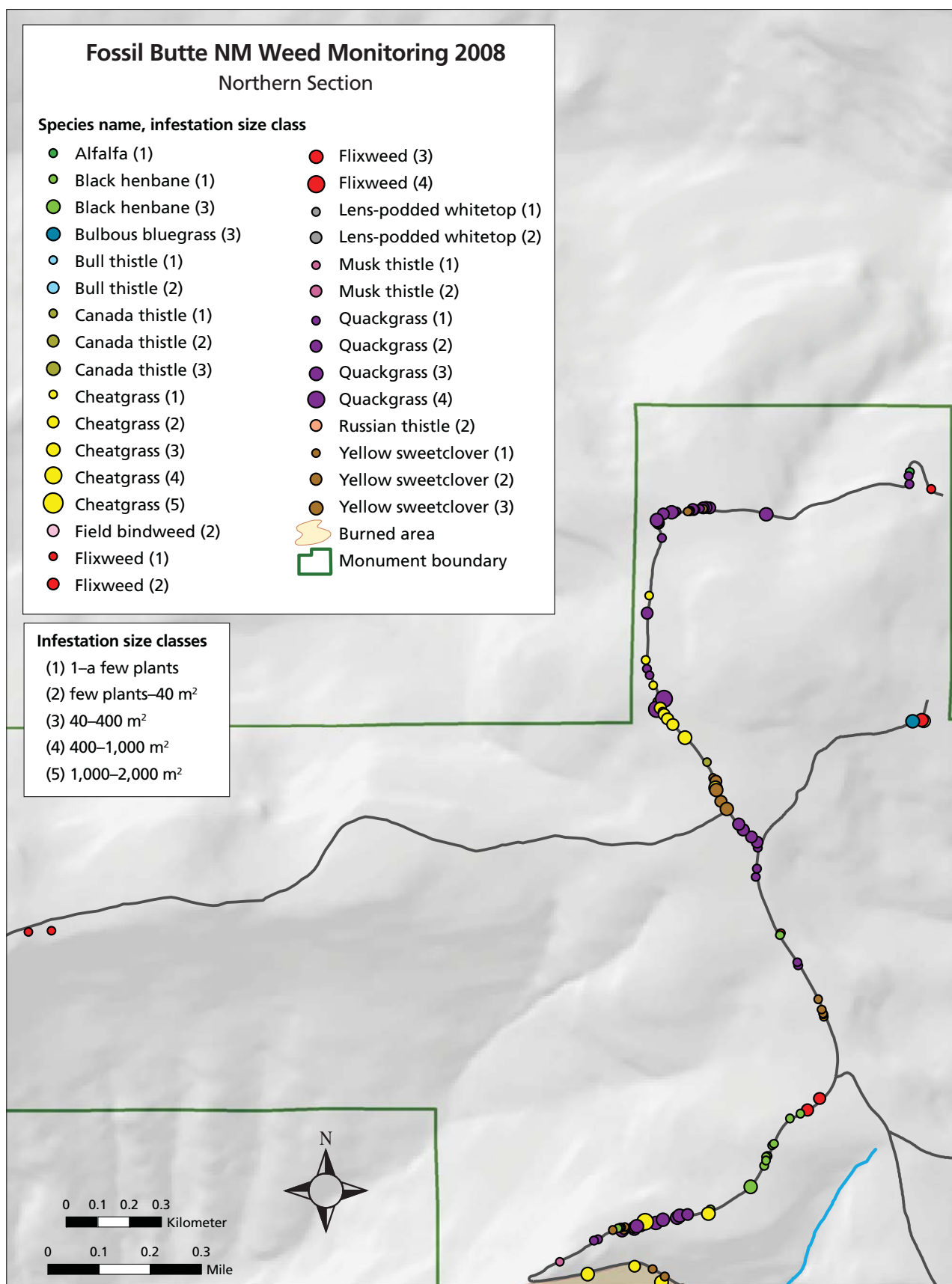


Figure 3.2-2. Invasive plants detected along monitoring routes, monitoring plots, and extra-area surveys in the northern portion of Fossil Butte National Monument, July 14–15, 2008.

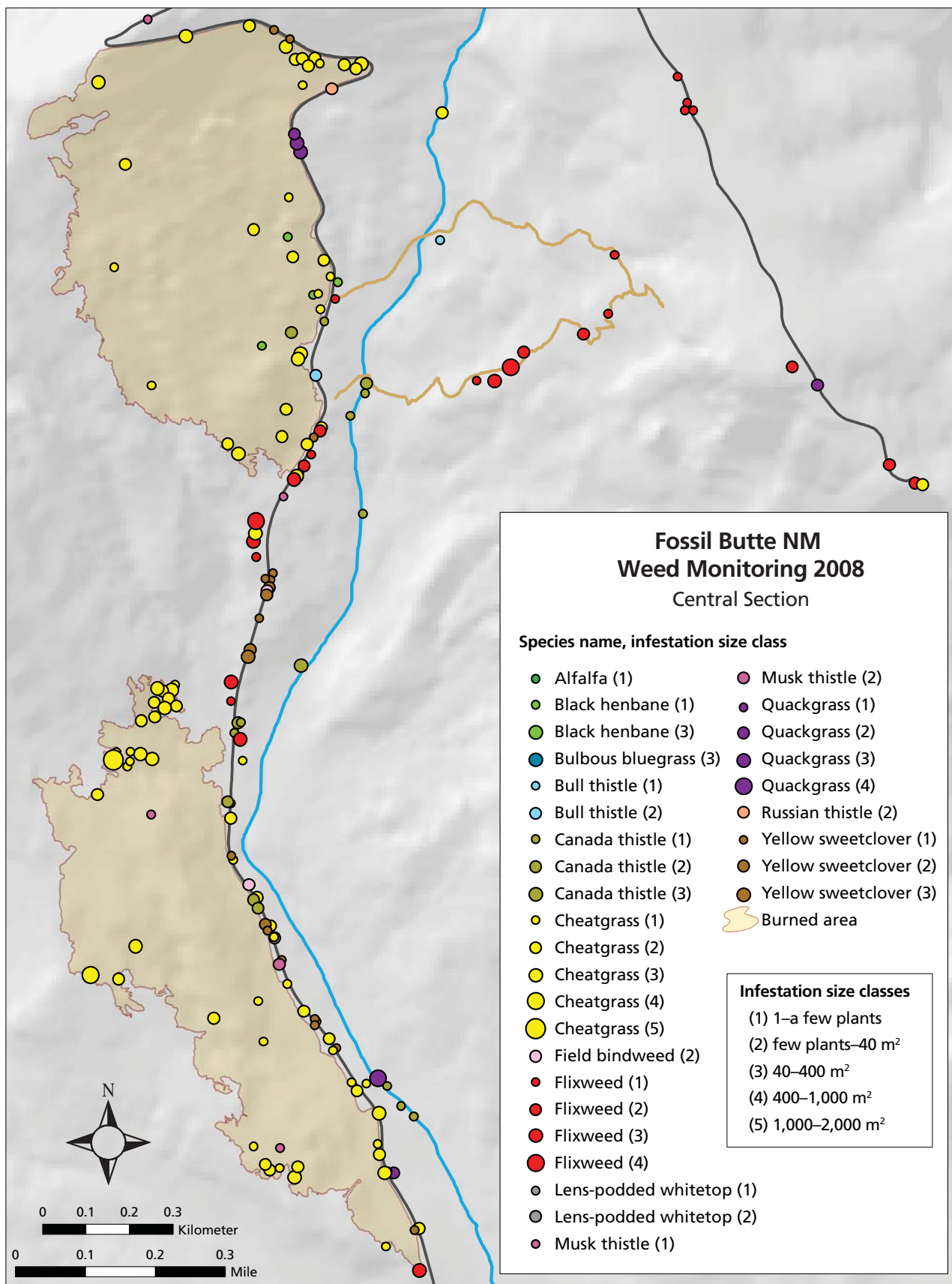


Figure 3.2-3. Invasive plants detected along monitoring routes, monitoring plots, and extra-area surveys in the central portion of Fossil Butte National Monument, July 14–15, 2008.

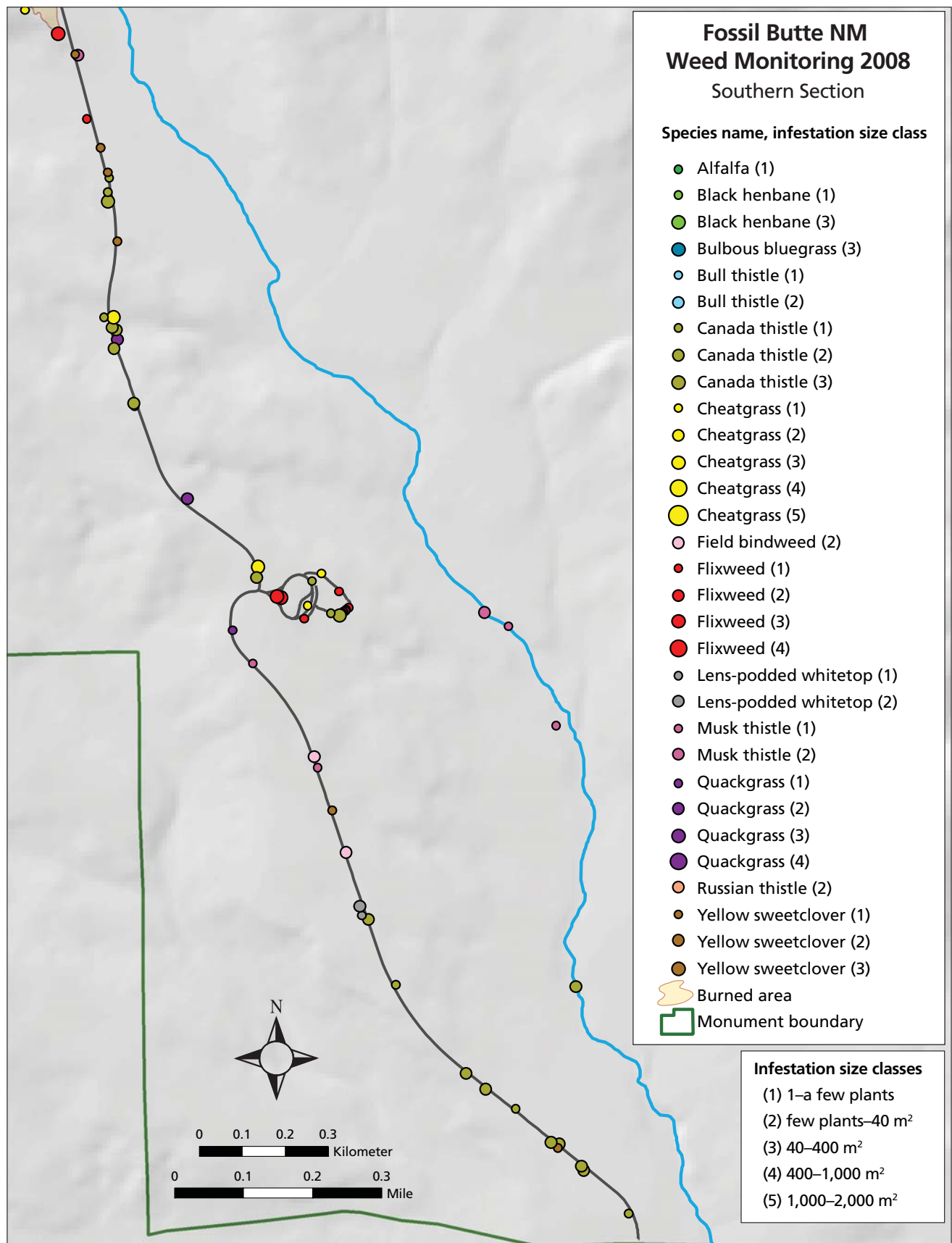


Figure 3.2-4. Invasive plants detected along monitoring routes, monitoring plots, and extra-area surveys in the southern portion of Fossil Butte National Monument, July 14–15, 2008.

Table 3.3. Number of monitoring plots where exotic plant species were detected, mean percent cover, and standard error (SE) by sampling area (management unit or monitoring route), Fossil Butte National Monument, July 14–15, 2008.

Scientific name	Common name	CHCR (7)		MAPA (5)		RUPO (3)		CHTR (5)		FOBU (23)	
		# of plots	% cover (SE)	# of plots	% cover (SE)	# of plots	% cover (SE)	# of plots	% cover (SE)	# of plots	% cover (SE)
<i>Descurainia sophia</i>	flixweed	1	0.86 (2.3)	0	0.0 (0.0)	0	0.0 (0.0)	0	0.0 (0.0)	1	0.26 (1.3)
<i>Halogeton glomeratus</i>	halogeton	1	0.19 (0.5)	0	0.0 (0.0)	0	0.0 (0.0)	0	0.0 (0.0)	1	0.06 (0.3)
<i>Lepidium perfoliatum</i>	clasping pepperweed	1	0.19 (0.5)	0	0.0 (0.0)	0	0.0 (0.0)	0	0.0 (0.0)	1	0.06 (0.3)
<i>Phleum pratense</i>	timothy	1	0.05 (0.1)	0	0.0 (0.0)	0	0.0 (0.0)	0	0.0 (0.0)	1	0.01 (0.1)
<i>Poa pratensis</i>	Kentucky bluegrass	2	1.02 (2.1)	0	0.0 (0.0)	0	0.0 (0.0)	2	0.57 (0.9)	4	0.43 (1.3)
<i>Polygonum aviculare</i>	prostrate knotweed	1	0.10 (0.3)	0	0.0 (0.0)	0	0.0 (0.0)	0	0.0 (0.0)	1	0.03 (0.1)
<i>Ranunculus testiculatus</i>	bur buttercup	1	0.02 (0.1)	0	0.0 (0.0)	0	0.0 (0.0)	1	0.07 (0.15)	2	0.02 (0.1)
<i>Tragopogon dubius</i>	goatsbeard	1	0.02 (0.1)	0	0.0 (0.0)	0	0.0 (0.0)	0	0.0 (0.0)	1	0.01 (0.03)
<i>Trifolium repens</i>	white clover	0	0.00 (0.0)	0	0.0 (0.0)	0	0.0 (0.0)	2	1.07 (1.9)	2	0.23 (0.9)
All species		3	2.45 (3.9)	0	0.0 (0.0)	0	0.0 (0.0)	3	1.70 (1.9)	6	1.12 (2.4)

Total number of plots per area or route are listed in parentheses in the header row. CHCR = Chicken Creek; MAPA = Main Park Road; RUPO = Ruby Point Road; CHTR = Chicken Creek Nature Trail; FOBU = Fossil Butte (all plots, including the sum of the previous four columns plus one plot each along Bullpen Two Track, Eagle Nest Point Road, and Cundick Ridge Road). *Thlaspi arvense* was detected during the walk of the plot outside the quadrats.

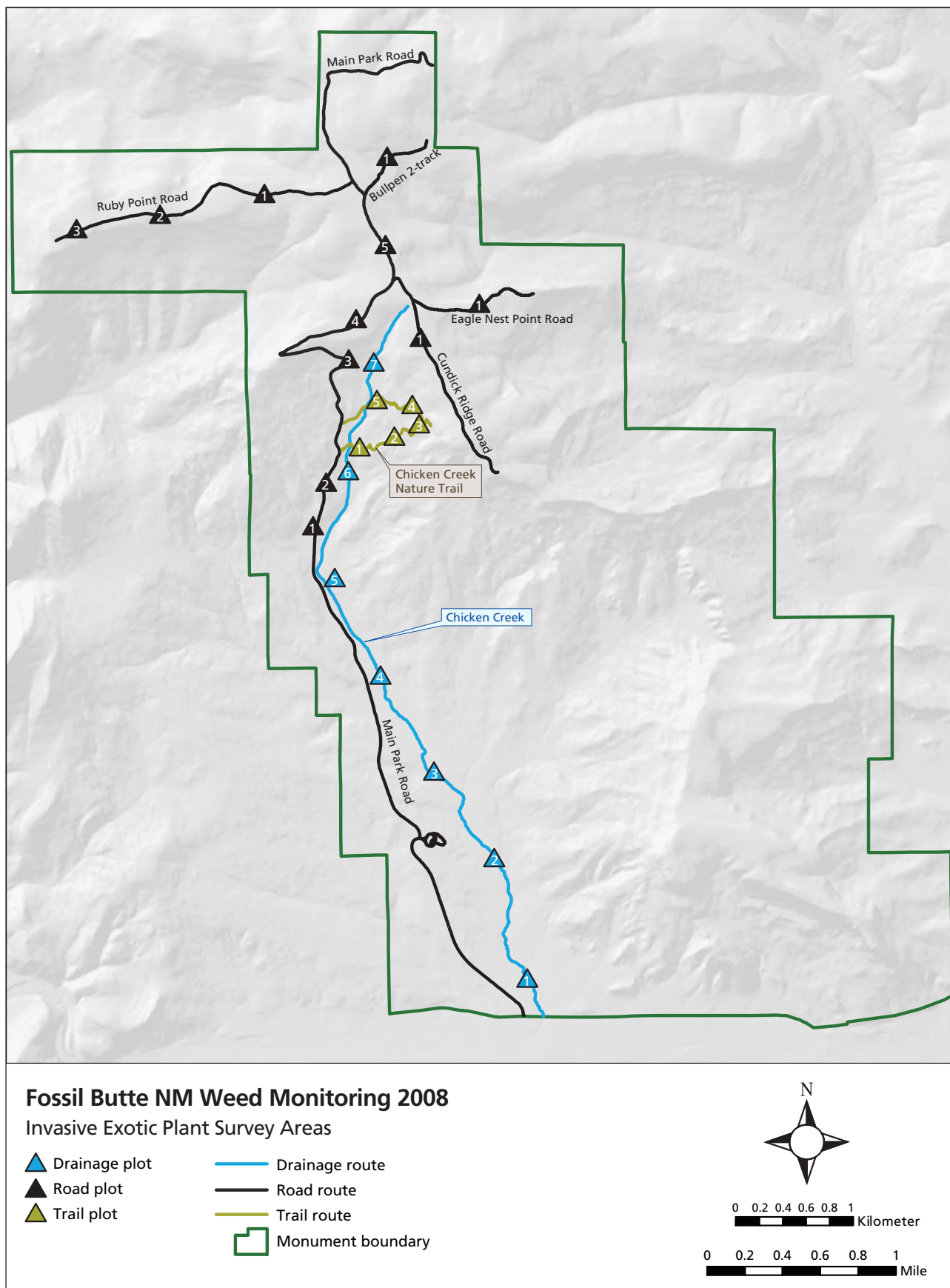


Figure 3.3. Monitoring plots established at Fossil Butte National Monument, July 14–15, 2008.

Table 3.4. Species observed and size of infestation detected during extra-area surveys of the Switchback and West Fork Units, Fossil Butte NM, July 14–15, 2008.

Scientific name	Common name	Infestation size class Number of infestations					Total infestations
		1	2	3	4	5	
<i>Bromus tectorum</i>	cheatgrass	19	28	14	1	1	63
<i>Carduus nutans</i>	musk thistle	2	0	0	0	0	2
<i>Cirsium arvense</i>	Canada thistle	0	1	0	0	0	1
<i>Descurainia sophia</i>	flixweed	0	0	1	0	0	1
<i>Hyoscyamus niger</i>	black henbane	4	0	0	0	0	4
All species		25	29	15	1	1	71

Infestation size classes

- 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)
- 5) 1,000–2,000 m² (0.25–0.5 acre)

4 Discussion

4.1 Changes to protocol based on 2008 pilot field season

We estimate that observers spent more than half of their field time establishing and collecting data from the monitoring plots and nested quadrats during the 2008 field season. In order to make the collection of quantitative data more efficient, we will make the following changes to the NCPN monitoring protocol for invasive exotic plants:

1. Eliminate the circular plot and collect data from 1-m² quadrats at set distances perpendicular from the monitoring route. This will decrease plot-establishment time and eliminate the plot walk-through.
2. Only collect data on the IEPs identified on the target list and other widespread IEPs in the plots, instead of on all species, as was done in 2008. By requiring observers to only learn target and dominant IEPs, data collection will take less time and require less botanical expertise.

Roads identified as two-tracks in the GIS layer are closed and heavily overgrown. They are probably not active weed corridors and may be either removed or placed on a longer rotation for subsequent surveys. Edges along regularly used roads should be the primary areas searched at FOBU.

4.2 Target IEP list

The methods used to determine the target IEP list adequately covered the species of management concern that were actually detected. We view the data from FOBU as being preliminary. Presence data for Priority 1 species are reliable; however, absence data are highly suspect for this year's sampling effort. Quackgrass was particularly troublesome, as it is very similar to native *Elymus* species and hybridizes with some of them. We were reluctant to record thistle rosettes because of the difficulty in accurately distinguishing between the exotics and several native thistle species.

4.3 Possibilities for management control

Invasive exotic plants are widespread along the Main Park Road at FOBU, but less prevalent in other areas. IEPs were detected at a rate of 1.2 per 100 m along the main road. The infestation rate at

the next-highest area, Cundick Ridge Road, was substantially lower, at 0.5 per 100 m. Cheatgrass is the most prevalent IEP, widespread along the Main Park Road and in the two burn units. Areas away from the Main Park Road had low detections of IEPs. It is also encouraging that 83% and 76% of infestations by species detected on monitoring routes or in the extra-area surveys, respectively, were less than 40 m² in size, indicating that rapid control of these infestations may limit their expansion. Preventing additional species from invading will give the native species a better chance to persist.

It should be noted that estimates of percent cover in this report (see Table 3.3, Appendix C) 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. Also, during 2008, NCPN crews focused on completing the extra-area surveys and covering large amounts of area with the monitoring routes. Because monitoring plots were tested at Golden Spike National Historic Site, only limited effort was expended to establish and measure plots at FOBU. Therefore, few conclusions can be drawn from the FOBU plot data. The number of plots will be expanded in 2009, using more efficient methods.

4.4 Future monitoring efforts

IEPs at GOSP will generally be monitored at the same time of year. Consistency in timing of monitoring should ensure consistency in detection probabilities and cover estimates of most species. For many species, sampling any time during May–September is not expected to drastically alter the chances of detecting invasive species larger than the minimum detection target size. The NCPN will add additional plots along the Main Park Road and cover the remaining monitoring routes in 2009. Long-term trend reporting will focus on trends in species distributions, trends in percent cover of individual species, and changes in IEP percent cover by monitoring routes.

4.5 New and rare species

These surveys detected one new species, Parry's rabbitbrush *Chrysothamnus parryi*, for the monument. This plant was common along the

Chicken Creek Nature Trail. It was not collected because it was not in flower. It is important to note that the rare thistleleaf pepperweed (*Lepidium integrifolium*) grows in Chicken Creek, and

should not be mistaken for the invasives, perennial pepperweed (*Lepidium latifolium*) or hoary cress (*Cardaria* spp.), during control efforts.

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Appendix A. Fossil Butte National Monument target invasive exotic plant list.

Scientific name	Common name	Scientific name	Common name
Priority 1		Priority 3	
1 <i>Alopecurus arundinaceus</i>	creeping foxtail	1 <i>Cardaria draba</i>	hoary cress
2 <i>Arctium minus</i>	common burdock	2 <i>Carduus acanthoides</i>	plumeless thistle
3 <i>Cardaria chalapensis</i>	lens-podded whitetop	3 <i>Centaurea solstitialis</i>	yellow starthistle
4 <i>Cardaria pubescens</i>	whitetop	4 <i>Chrysanthemum leucanthemum</i>	oxeye daisy
5 <i>Carduus nutans</i>	musk thistle	5 <i>Chondrilla juncea</i>	rush skeltonweed
6 <i>Centaurea diffusa</i>	diffuse knapweed	6 <i>Elaeagnus angustifolia</i>	Russian olive
7 <i>Centaurea maculosa</i>	spotted knapweed	7 <i>Euphorbia esula</i>	leafy spurge
8 <i>Centaurea repens</i>	Russian knapweed	8 <i>Franseria discolor</i>	skeltoneleaf bursage
9 <i>Cirsium arvense</i>	Canada thistle	9 <i>Hypericum perforatum</i>	common St. Johnswort
10 <i>Cirsium vulgare</i>	bull thistle	10 <i>Knautia arvensis</i>	field scabious
11 <i>Convolvulus arvensis</i>	field bindweed	11 <i>Linaria vulgaris</i>	yellow toadflax
12 <i>Cynoglossum officinale</i>	houndstongue	12 <i>Lythrum salicaria</i>	purple loosertrife
13 <i>Elymus repens</i> / <i>Agropyron repens</i>	quackgrass	13 <i>Onopordum acanthium</i>	Scotch thistle
14 <i>Hyoscyamus niger</i>	black henbane	14 <i>Tanacetum vulgare</i>	common tansy
15 <i>Isatis tinctoria</i>	Dyer's woad		
16 <i>Kochia scoparia</i>	kochia		
17 <i>Lepidium latifolium</i>	perennial pepperweed		
18 <i>Linaria dalmatica</i>	Dalmatian toadflax		
19 <i>Melilotus officinalis</i>	yellow sweetclover		
20 <i>Sonchus arvensis</i> / <i>S. ulginosis</i>	perennial sowthistle		
21 <i>Tamarix ramosissima</i>	saltcedar		
22 <i>Verbascum thapsus</i>	common mullein		
Priority 2			
1 <i>Agropyron cristatum</i>	crested wheatgrass		
2 <i>Bromus inermis</i>	smooth brome		
3 <i>Bromus japonicus</i>	Japanese brome		
4 <i>Bromus tectorum</i>	downy brome/ cheatgrass		
5 <i>Dactylis glomerata</i>	orchard grass		
6 <i>Descurainia sophia</i>	flixweed		
7 <i>Halogeton glomeratus</i>	halogeton		
8 <i>Lepidium perfoliatum</i>	clasping pepperweed		
9 <i>Malcolmia africana</i>	African mustard		
10 <i>Marrubium vulgare</i>	white horehound		
11 <i>Phleum pratense</i>	timothy		
12 <i>Rumex crispus</i>	curly dock		
13 <i>Salsola tragus</i>	Russian thistle		
14 <i>Thlaspi arvense</i>	field pennycress		
15 <i>Tragopogon dubius</i>	goatsbeard		

Appendix B. List of all exotic plant invasions detected on monitoring routes at Fossil Butte National Monument, July 14–15, 2008.

Monitoring route	Scientific name	Common name	Infestation size class	Canopy cover class	Northing	Easting
Visitor Center	<i>Cirsium arvense</i>	Canada thistle	1	2	4631635.656	519044.842
			1	2	4631709.641	519001.276
			3	3	4631629.204	519065.490
	<i>Bromus tectorum</i>	cheatgrass	1	5	4631727.667	519022.803
			1	2	4631643.304	519080.678
			1	3	4631635.121	519071.953
			1	4	4631652.650	518991.390
	<i>Descurainia sophia</i>	flixweed	1	5	4631685.438	519064.046
			1	3	4631648.238	519085.818
			1	2	4631639.158	519073.923
			1	3	4631622.479	518982.797
			3	4	4631671.946	518929.514
			3	2	4631674.383	518919.763
	<i>Carduus nutans</i>	musk thistle	1	1	4631641.125	519078.414
Ruby Point Road	<i>Descurainia sophia</i>	flixweed	1	3	4636907.189	516186.746
			1	2	4636903.644	516114.394
Main Park Road	<i>Medicago sativa</i>	alfalfa	1	3	4638348.682	518881.859
	<i>Hyoscyamus niger</i>	black henbane	1	3	4635262.209	518221.738
			1	1	4635978.875	518029.979
			1	1	4635973.773	517973.538
			1	1	4635973.701	517970.933
			1	2	4635971.881	517965.665
			1	1	4636333.695	518539.501
			1	1	4636317.979	518505.445
			1	2	4636232.631	518449.756
			1	2	4636200.333	518435.372
			1	1	4636197.195	518431.253
			1	2	4636031.766	518255.701
			1	1	4636168.722	518424.475
			1	1	4636185.324	518430.504
			1	1	4636237.308	518455.000
			1	1	4636893.644	518473.860
			3	1	4636103.680	518382.432
	<i>Cirsium vulgare</i>	bull thistle	2	2	4635047.259	518171.583
	<i>Cirsium arvense</i>	Canada thistle	1	2	4630481.188	519475.001
			1	3	4630769.706	519196.021
			1	2	4637436.590	518245.039
			1	5	4632648.760	518529.172
			1	2	4633213.352	518337.150
			1	1	4630236.800	519738.341
			1	1	4632117.400	518588.191
			1	1	4632324.905	518517.036

Appendix B. List of all exotic plant invasions detected on monitoring routes at Fossil Butte NM, July 14–15, 2008, cont.

Monitoring route	Scientific name	Common name	Infestation size class	Canopy cover class	Northing	Easting
Main Park Road	<i>Cirsium arvense</i>	Canada thistle	1	1	4632616.268	518525.423
			1	2	4634247.426	517998.107
			1	1	4634223.745	517983.230
			1	2	4635171.565	518190.513
			3	3	4632593.867	518526.517
			2	2	4630399.754	519576.456
			2	1	4630921.507	519132.420
			2	3	4632295.040	518545.332
			2	1	4632300.069	518535.933
			2	1	4634064.261	517968.028
			2	3	4633839.326	518027.660
			2	2	4633819.599	518038.352
			2	2	4630338.144	519633.294
			2	2	4630347.290	519627.893
			2	2	4630402.581	519557.501
			2	3	4630526.896	519405.631
			2	2	4630563.539	519360.184
			2	3	4631718.383	518871.905
			2	2	4632124.404	518585.651
			2	3	4632251.539	518540.396
			2	3	4634246.966	517991.708
	<i>Bromus tectorum</i>	cheatgrass	1	2	4637961.015	518063.586
			1	5	4637909.393	518056.730
			1	2	4637758.541	518052.466
			1	5	4637678.897	518077.100
			1	5	4637627.277	518089.566
			1	2	4637595.397	518105.692
			1	5	4633414.992	518287.259
			1	2	4633558.532	518171.759
			1	1	4633753.522	518074.737
			1	1	4633931.575	517979.956
			1	1	4633644.864	518105.120
			1	1	4633491.452	518210.573
			1	1	4633418.334	518253.075
			1	3	4634159.365	518002.344
			1	5	4634820.873	518131.695
			3	2	4637514.702	518176.034
			3	1	4637357.237	518272.204
			3	2	4631743.159	518875.867
			3	2	4632324.564	518538.992
			3	2	4633347.294	518316.784
			3	2	4633209.239	518329.170
			3	3	4634682.853	518031.543

Appendix B. List of all exotic plant invasions detected on monitoring routes at Fossil Butte NM, July 14–15, 2008, cont.

Monitoring route	Scientific name	Common name	Infestation size class	Canopy cover class	Northing	Easting
Main Park Road	<i>Bromus tectorum</i>	cheatgrass	3	4	4634814.567	518126.433
			3	4	4636017.958	518249.807
			4	3	4635992.304	518051.327
			2	4	4637607.925	518098.776
			2	1	4637586.426	518111.064
			2	4	4637573.134	518121.502
			2	2	4637554.85	518137.397
			2	2	4633081.696	518408.843
			2	1	4633518.412	518201.984
			2	1	4633778.032	518066.725
			2	1	4633844.622	518034.773
			2	3	4634026.607	517974.895
			2	1	4633582.257	518143.078
			2	1	4633398.407	518266.098
			2	3	4634926.488	518184.023
	<i>Convolvulus arvensis</i>	field bindweed	2	3	4631078.418	519080.130
			2	2	4631301.338	519005.937
			2	3	4633873.066	518016.388
			2	2	4634550.774	518058.744
	<i>Descurainia sophia</i>	flixweed	1	4	4638296.269	518949.909
			1	4	4632786.245	518477.007
			1	3	4634296.335	517975.514
			1	4	4634629.058	518033.141
			1	4	4634864.138	518160.388
			1	4	4636899.900	518476.679
			3	3	4634208.980	517996.587
			3	4	4634340.837	517976.004
			3	3	4634663.787	518027.025
			3	4	4634807.770	518120.556
			4	3	4634711.220	518033.289
			2	2	4634919.580	518180.570
			2	4	4634838.035	518144.304
			2	3	4636379.539	518599.070
			2	3	4636345.043	518560.794
	<i>Cardaria chalapensis</i>	lens-podded whitetop	1	4	4630930.817	519116.430
			2	3	4630952.278	519111.853
	<i>Carduus nutans</i>	musk thistle	1	5	4631275.491	519014.697
			1	5	4631517.999	518863.097
			1	2	4635867.004	517783.394
			1	2	4634767.911	518096.250
			2	1	4632934.733	518456.020
			2	2	4633689.514	518086.332

Appendix B. List of all exotic plant invasions detected on monitoring routes at Fossil Butte NM, July 14–15, 2008, cont.

Monitoring route	Scientific name	Common name	Infestation size class	Canopy cover class	Northing	Easting
Main Park Road	<i>Elymus repens</i>	quackgrass	1	5	4631595.620	518815.957
			1	5	4638142.138	518103.368
			1	4	4637731.164	518055.950
			1	5	4637710.047	518065.471
			1	3	4638336.343	518878.144
			1	3	4638310.558	518880.744
			1	3	4638233.582	518222.222
			1	3	4638229.676	518210.035
			1	3	4638226.310	518204.463
			1	3	4638225.245	518191.484
			1	3	4638224.313	518150.475
			1	3	4638219.092	518142.698
			1	2	4635938.677	517902.064
			1	2	4635934.647	517889.499
			1	3	4636797.609	518530.885
			1	3	4636808.163	518528.755
			1	2	4637076.700	518398.301
			1	3	4637102.501	518401.904
			1	2	4637168.169	518403.967
			3	4	4638216.250	518431.672
			3	3	4638222.782	518133.781
			3	3	4638197.942	518088.497
			3	3	4635561.806	518135.400
			3	3	4635582.736	518127.397
			3	3	4635966.877	517978.815
			3	3	4635972.181	518017.531
			3	3	4635989.240	518084.292
			3	3	4636005.747	518151.024
			3	2	4636012.063	518159.771
			3	3	4635999.567	518107.751
			3	3	4635978.451	518024.172
			4	4	4637603.059	518087.903
			4	3	4637636.167	518109.651
			2	5	4638189.396	518093.434
			2	4	4637905.566	518057.442
			2	4	4631901.391	518710.403
			2	4	4632272.019	518547.828
			2	4	4633209.202	518351.088
			2	3	4637242.415	518344.742
			2	4	4638235.550	518252.912
			2	3	4638237.098	518243.670
			2	3	4638236.437	518233.189
			2	3	4638231.614	518200.957

Appendix B. List of all exotic plant invasions detected on monitoring routes at Fossil Butte NM, July 14–15, 2008, cont.

Monitoring route	Scientific name	Common name	Infestation size class	Canopy cover class	Northing	Easting
Main Park Road	<i>Elymus repens</i>	quackgrass	2	3	4638216.843	518109.008
			2	3	4635603.260	518121.580
			2	3	4636016.147	518185.033
			2	3	4637185.968	518403.083
			2	3	4637202.561	518385.329
			2	3	4637224.455	518358.912
	<i>Salsola tragus</i>	Russian thistle	2	3	4635706.959	518207.314
	<i>Melilotus officianlis</i>	yellow sweetclover	1	5	4631176.088	519047.619
			1	5	4638186.284	518093.795
			1	5	4637387.361	518264.392
			1	5	4632501.623	518547.395
			1	5	4632661.192	518525.757
			1	5	4632719.536	518508.417
			1	5	4632936.260	518450.130
			1	5	4633497.110	518219.071
			1	5	4633564.237	518168.413
			1	5	4633700.023	518092.414
			1	5	4633940.523	517976.776
			1	5	4634060.936	517975.158
			1	3	4633768.565	518059.433
			1	5	4633550.299	518168.345
			1	4	4634591.188	518072.740
			1	3	4634575.436	518065.757
			1	3	4638233.552	518232.793
			1	3	4638226.991	518193.006
			1	5	4638224.545	518184.061
			1	2	4630389.953	519573.565
			1	4	4634487.134	518040.755
			1	2	4633078.036	518398.648
			1	4	4634578.081	518054.742
			1	5	4634904.629	518166.582
			1	4	4635821.370	518111.989
			1	3	4635843.612	518074.027
			1	2	4635967.623	517984.176
			1	4	4635969.800	518014.361
			1	2	4635974.404	518038.871
			1	3	4635995.739	518109.640
			1	2	4635976.348	517987.214
			1	2	4635975.186	517975.161
			1	2	4635967.160	517949.413
			1	2	4636636.977	518612.946
			1	1	4636643.914	518611.907
			1	4	4636647.455	518609.706

Appendix B. List of all exotic plant invasions detected on monitoring routes at Fossil Butte NM, July 14–15, 2008, cont.

Monitoring route	Scientific name	Common name	Infestation size class	Canopy cover class	Northing	Easting
Main Park Road	<i>Melilotus officianlis</i>	yellow sweetclover	1	3	4636659.668	518605.708
			1	4	4636692.437	518594.473
			3	1	4637349.835	518275.232
			3	1	4637290.191	518307.422
			3	3	4634398.597	518014.845
			2	2	4637377.010	518273.704
			2	1	4637314.386	518288.357
			2	3	4633751.420	518075.735
			2	3	4633781.661	518054.481
			2	2	4634558.159	518063.977
			2	3	4634540.805	518057.279
			2	4	4634415.288	518019.552
Cundick Ridge Road	<i>Bromus tectorum</i>	cheatgrass	2	3	4634795.674	519569.349
	<i>Descurainia sophia</i>	flixweed	1	2	4635734.946	519004.767
			1	2	4635675.127	519027.058
			1	2	4635657.806	519021.791
			1	2	4635657.680	519041.546
			2	2	4635066.756	519269.239
			2	2	4634841.301	519492.596
			2	2	4634799.455	519551.942
	<i>Elymus repens</i>	quackgrass	2	2	4635024.867	519326.971
Chicken Creek Nature Trail	<i>Cirsium vulgare</i>	bull thistle	1	5	4635358.901	518457.052
	<i>Descurainia sophia</i>	flixweed	1	5	4635034.858	518541.917
			1	5	4635189.339	518844.879
			1	5	4635324.628	518859.174
			1	5	4635222.564	518215.472
			3	3	4635034.259	518582.801
			4	2	4635065.688	518620.208
			2	3	4635100.508	518649.683
			2	1	4635141.635	518787.861
Chicken Creek	<i>Cirsium arvense</i>	Canada thistle	1	5	4633363.979	518368.056
			1	2	4633339.838	518396.555
			1	2	4635005.969	518284.566
			1	5	4634953.387	518250.414
			1	5	4634728.556	518279.244
			1	3	4633409.749	518334.797
			3	3	4634378.557	518136.749
			2	2	4630765.431	519615.353
			2	2	4635028.614	518287.890
	<i>Bromus tectorum</i>	cheatgrass	2	5	4635652.138	518461.578
	<i>Carduus nutans</i>	musk thistle	1	5	4631604.885	519458.272
			1	5	4631373.496	519569.450
			2	2	4631637.340	519402.677

Appendix B. List of all exotic plant invasions detected on monitoring routes at Fossil Butte NM, July 14–15, 2008, cont.

Monitoring route	Scientific name	Common name	Infestation size class	Canopy cover class	Northing	Easting
Chicken Creek	<i>Elymus repens</i>	quackgrass	4	3	4633427.315	518314.322
Bullpen two-track	<i>Poa bulbosa</i>	bulbous bluegrass	3	4	4637564.813	518891.311
	<i>Bromus tectorum</i>	cheatgrass	3	4	4637566.183	518925.569
	<i>Descurainia sophia</i>	flixweed	3	3	4637569.219	518920.651

Infestation size classes:

- 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)
- 5) 1,000–2,000 m² (0.25–0.5 acre).

Canopy cover classes:

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

Appendix C. Invasive exotic plant percent cover detected by monitoring plot, Fossil Butte National Monument, July 14–15, 2008.

Route/ Plot	Scientific name	Common name	Mean cover	Easting	Northing
CHCR 1	None			4630498.108	519775.906
CHCR 2	None			4631532.822	519511.723
CHCR 3	None			4632251.356	518965.105
CHCR 4	<i>Tragopogon dubius</i>	goatsbeard	0.17	4633070.582	518543.651
	<i>Polygonum aviculare</i>	prostrate knotweed	0.67		
	<i>Lepidum perfoliatum</i>	clasping pepperweed	1.33		
	<i>Halogeton glomeratus</i>	halogeton	1.33		
	<i>Descurainia sophia</i>	flixweed	6.00		
	<i>Ranunculus testiculatus</i>	bur buttercup	0.17		
CHCR 5	<i>Poa pratensis</i>	Kentucky bluegrass	1.50	4633906.531	518036.673
CHCR 6	<i>Poa pratensis</i>	Kentucky bluegrass	5.67	4634824.750	518262.692
	<i>Phleum pratense</i>	timothy	0.33		
CHCR 7	None			4635725.127	518466.900
BULL 1	None			4637481.123	518597.503
MAPA 1	None			4634341.502	518010.249
MAPA 2	None			4634722.036	518084.290
MAPA 3	None			4635744.693	518308.606
MAPA 4	None			4636095.680	518348.211
MAPA 5	None			4636747.921	518580.335
RUPO 1	None			4637146.823	517548.702
RUPO 2	None			4636980.205	516675.202
RUPO 3	None			4636844.270	515898.778
ENPR 1	None			4636205.102	519391.904
CURR 1	None			4635945.905	518883.595
CHTR 1	<i>Poa pratensis</i>	Kentucky bluegrass	0.83	4634996.348	518372.330
	<i>Trifolium repens</i>	white clover	1.00		
CHTR 2	<i>Ranunculus testiculatus</i>	bur buttercup	0.33	4635098.083	518658.917
	<i>Trifolium repens</i>	white clover	4.33		
CHTR 3	None			4635232.773	518868.775
CHTR 4	None			4635338.276	518806.644
CHTR 5	<i>Poa pratensis</i>	Kentucky bluegrass	2.00	4635427.452	518515.038

CHCR = Chicken Creek; BULL = Bullpen Two Track; MAPA = Main Park Road; RUPO = Ruby Point Road; ENPR = Eagle Nest Point Road; CURR = Cundick Ridge Road; CHTR = Chicken Creek Nature Trail.

Appendix D. List of all exotic plant invasions detected during extra-area surveys of the Switchback and West Fork burn units at Fossil Butte National Monument, July 14–15, 2008.

Burn unit	Scientific name	Common name	Infestation size class	Canopy cover class	Northing	Easting
West Fork	<i>Bromus tectorum</i>	cheatgrass	1	3	4634334.478	517846.257
			1	3	4634146.667	517736.661
			1	3	4634157.904	517742.300
			1	3	4634179.867	517743.438
			1	3	4634179.206	517710.667
			1	3	4633039.827	518332.746
			1	3	4633270.579	518027.541
			1	3	4633220.110	518086.949
			1	4	4633605.044	518037.542
			1	4	4633512.275	518050.247
			1	3	4633276.409	518313.449
			5	2	4634161.151	517704.559
			3	2	4634322.436	517838.855
			3	3	4634326.105	517806.273
			3	3	4634280.160	517823.154
			3	3	4634163.224	517794.045
			3	2	4634173.799	517767.011
			3	3	4633731.722	517755.483
			3	3	4633199.354	518121.922
			4	3	4633665.563	517651.302
			2	2	4634320.520	517817.123
			2	3	4634251.353	517768.394
			2	3	4634293.040	517798.609
			2	3	4634302.873	517830.838
			2	2	4634285.022	517849.812
			2	3	4634259.498	517799.225
			2	3	4634080.845	517666.943
			2	3	4633656.259	517717.090
			2	3	4633566.433	517935.237
			2	3	4633215.589	518064.651
			2	3	4633229.118	518054.460
			2	3	4633222.987	518129.448
			2	2	4633251.962	518316.959
			2	5	4634888.201	518150.454
	<i>Descurainia sophia</i>	flixweed	3	4	4632985.170	518409.540
	<i>Carduus nutans</i>	musk thistle	1	3	4634035.840	517791.578
			1	4	4633267.277	518088.229
Switchback	<i>Hyoscyamus niger</i>	black henbane	1	4	4635365.975	518105.906
			1	4	4635308.456	518187.164
			1	3	4635231.810	518164.371
			1	3	4635114.601	518046.670
	<i>Cirsium arvense</i>	Canada thistle	2	3	4635145.792	518114.359

Appendix D. List of all exotic plant invasions detected during extra-area surveys of the Switchback and West Fork burn units at Fossil Butte NM, July 14–15, 2008, cont.

Burn unit	Scientific name	Common name	Infestation size class	Canopy cover class	Northing	Easting
Switchback	<i>Bromus tectorum</i>	cheatgrass	1	3	4635716.075	518140.352
			1	3	4635766.254	518180.597
			1	4	4635457.685	518109.244
			1	4	4635296.693	517706.089
			1	4	4635275.473	518204.916
			1	4	4635235.323	518177.194
			1	3	4635199.727	518181.261
			1	3	4635023.905	517792.468
			3	3	4635765.207	518275.815
			3	3	4635803.846	518102.196
			3	3	4635722.409	517669.783
			3	3	4635828.398	517871.297
			3	3	4635084.772	518130.589
			3	3	4635097.245	518136.250
			3	3	4634865.974	517992.799
			2	3	4635753.740	518263.084
			2	3	4635762.761	518235.997
			2	3	4635532.829	517731.110
			2	3	4635759.978	518153.276
			2	3	4635777.787	518168.726
			2	3	4635776.835	518139.867
			2	3	4635775.666	518123.989
			2	3	4635852.747	518017.951
			2	3	4635382.778	518027.960
			2	3	4635320.062	518118.394
			2	3	4635312.776	518189.964
			2	3	4634968.345	518102.603
			2	3	4634889.907	517968.357
			2	3	4634906.254	518093.301

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