



Invasive Exotic Plant Monitoring at Golden Spike National Historic Site *2008 Pilot Field Season*

Natural Resource Technical Report NPS/NCPN/NRTR—2009/226



ON THE COVER

NCPN field crew setting up a monitoring plot at Golden Spike NHS, summer 2008. NPS photo.

Invasive Exotic Plant Monitoring at Golden Spike National Historic Site

2008 Pilot Field Season

Natural Resource Technical Report NPS/NCPN/NRTR—2009/226

Prepared by

Dustin W. Perkins
Rebecca Weissinger
Northern Colorado Plateau Network
P.O. Box 848
Moab, UT 84532

Editing and Design

Alice Wondrak Biel
Northern Colorado Plateau Network
P.O. Box 848
Moab, UT 84532

July 2009

U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Fort Collins, Colorado

The National Park Service, Natural Resource Program Center publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Technical Report Series is used to disseminate results of scientific studies in the physical, biological, and social sciences for both the advancement of science and the achievement of the National Park Service mission. The series provides contributors with a forum for displaying comprehensive data that are often deleted from journals because of page limitations.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data.

Views, statements, findings, conclusions, recommendations, and data in this report are those of the author(s) and do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

This report is available from the Northern Colorado Plateau Network website, <http://www.nature.nps.gov/im/units/NCPN>, as well as at the Natural Resource Publications Management web site, <http://www.nature.nps.gov/publications/NRPM>.

Please cite this publication as:

Perkins, D. W., and R. Weissinger. 2009. Invasive exotic plant monitoring at Golden Spike National Historic Site: 2008 pilot field season. Natural Resource Technical Report NPS/NCPN/NRTR—2009/226. National Park Service, Fort Collins, Colorado.

Contents

- Figures v
- Tables v
- Acronyms vii
- Abstract ix
- Acknowledgements xi
- 1 Introduction 1
- 2 Methods..... 3
 - 2.1 Developing a park target invasive exotic plant list..... 3
 - 2.2 Monitoring routes 3
 - 2.2.1 Survey parameters 3
 - 2.2.2 Data collection methods..... 4
 - 2.2.3 Analysis..... 5
 - 2.3 Monitoring plots..... 5
 - 2.3.1 Plot establishment 5
 - 2.3.2 Data collection methods..... 5
 - 2.3.3 Analysis..... 5
- 3 Results..... 7
 - 3.1 Target invasive exotic plant list 7
 - 3.2 Monitoring routes 7
 - 3.3 Monitoring plots..... 8
- 4 Discussion 13
 - 4.1 Changes to protocol based on 2008 pilot field season..... 13
 - 4.2 Target IEP list..... 13
 - 4.3 Possibilities for management control 13
 - 4.4 Future monitoring efforts..... 13
 - 4.5 New species..... 13
- 5 Literature Cited 15
- Appendix A. Golden Spike National Historic Site target invasive exotic plant list..... 17
- Appendix B. List of all exotic plant invasions detected on monitoring routes, Golden Spike NHS, July 12–13, 2008. 18
- Appendix C. Invasive exotic plant percent cover detected by monitoring plot, Golden Spike NHS, July 12–13, 2008. 21

Figures

Figure 2.2.1.3. In most cases, the effective detection distance (EDD) for a minimum detection target size (MDTS) at Golden Spike NHS was 40 meters, making the effective detection swath width (EDSW) a distance of 80 meters (from Andersen and Dewey 2007). 4

Figure 3.3-1. Invasive plant monitoring routes, monitoring plots, and invasives detected along monitoring routes, Big Fill area, Golden Spike NHS, July 12–13, 2008. 10

Figure 3.3-2. Invasive plant monitoring routes, monitoring plots, and invasives detected along monitoring routes, Last Spike administrative area, Golden Spike NHS, July 12–13, 2008. 11

Tables

Table 3.1. List of invasive exotic plants recorded, Golden Spike NHS, July 12–13, 2008. 8

Table 3.2-1. Number of IEP infestations per route surveyed, Golden Spike NHS, July 12–13, 2008. 9

Table 3.2-2. Size of infestation detected for Priority 1 species along monitoring routes, Golden Spike NHS, July 12–13, 2008..... 9

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), Golden Spike NHS, July 12–13, 2008..... 12

Acronyms

EDD	effective detection distance
EDSW	effective detection swath width
GOSP	Golden Spike National Historic Site
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 the integrity and biodiversity of natural ecosystems, 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 Golden Spike National Historic Site (GOSP) in 2008, when methods were tested at GOSP and Fossil Butte National Monument (FOBU). These methods included (1) rapid-monitoring routes that focused on locating the highest-priority IEPs and (2) monitoring plots that provided more quantitative information on a wider range of IEPs. On July 12–13, 2008, 25 IEP species were detected on monitoring routes and plots that covered all major roads, trails, and riparian areas at GOSP. IEPs are widespread at GOSP, with at least one IEP present on every monitoring route and monitoring plot. Four taxa, crested wheatgrass (*Agropyron cristatum*), brome (*Bromus* spp.), field bindweed (*Convolvulus arvensis*), and redstem storksbill (*Erodium cicutarium*), are widespread and may be beyond management control. Several other species are present in small, localized invasions that have a greater chance of being successfully controlled through management actions. Based on the results from this season, the NCPN will make two changes to its invasive exotic plant monitoring 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 test the revised protocols in other network parks with different plant communities than GOSP and FOBU. The network will return to GOSP for a second year of monitoring in 2010.

Acknowledgements

S. Dewey assisted with questions on methods. A. Wight was extremely helpful in generating routes, plots, and other GIS information. T. Benson reviewed the target invasive exotic plant list and this report, assisted with site logistics, and provided site history. D. Witwicki improved this report with her thoughtful review. Field work was conducted by S. Topp and G. Lenhart. Data management was provided by H. Thomas. D. Perry assisted with administrative details.

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 Golden Spike National Historic Site (GOSP) in 2008. The network’s invasive exotic plant protocol will be adjusted based on this pilot work at GOSP, as well as work done at Fossil Butte National Monument.

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 GOSP (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 GOSP using the parameters described in the following sections.

2.2.1.1 Minimum detection target size

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 Russian olive (*Elaeagnus angustifolia*) and saltcedar (*Tamarix ramosissima*), is possible due to their large size, single plants of other species, such as field bindweed (*Convolvulus arvensis*) or sulfur cinquefoil (*Potentilla recta*), are nearly impossible to detect in most field conditions.

2.2.1.2 Effective detection distance

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. We established an EDD for GOSP of 40 m, in most cases. On a few routes with dense vegetation, the EDD was reduced to 20 or 30 m.

2.2.1.3 Effective detection swath width

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. In most cases, the EDSW at GOSP was 80 m.

2.2.1.4 Patch separation resolution

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

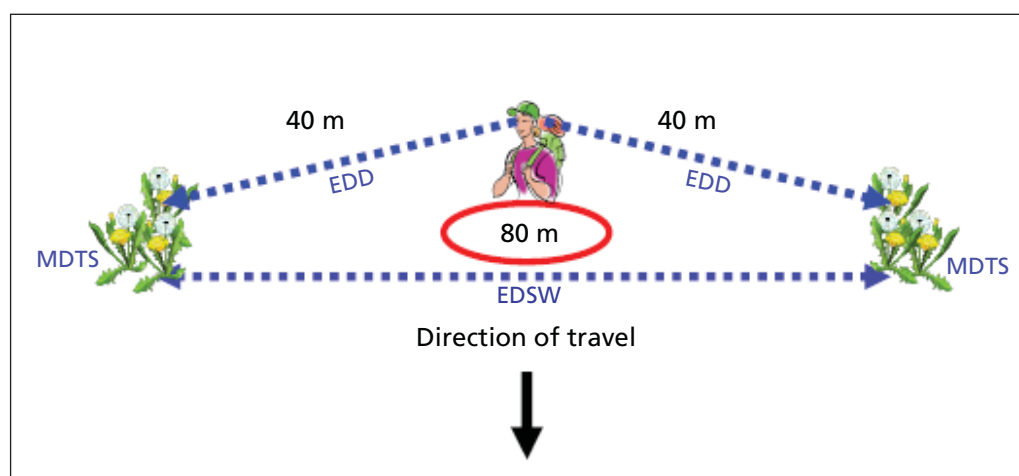


Figure 2.2.1.3. In most cases, the effective detection distance (EDD) for a minimum detection target size (MDTS) at Golden Spike NHS was 40 meters, making the effective detection swath width (EDSW) a distance of 80 meters (from Andersen and Dewey 2007).

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 roads, 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 80 m EDSW on each side of the road (160 m total for both sides) in most cases. For single-track trails and drainages, we walked the center of the trail or drainage in only one direction, for a total coverage of 80 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 80 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 recorded during surveys of monitoring routes. 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). In most cases, we established plots with three 1-m² vegetation quadrats every 400 m along each monitoring route. Due to topography and because we were testing new methods, we occasionally placed plots every 200 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

For each quadrat, we recorded percent cover of each plant species (including non-IEPs) 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 on the quadrats. We also recorded the following ancillary data for the plot: slope, aspect, diameter at breast height (dbh) (1.4 m) 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), distance to road (and to crops, if the distances were <100 m), and descriptions of disturbances.

2.3.3 Analysis

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.

Three *Bromus* species were detected on the monitoring plots; however, because there may have been some misidentification between the three species, they were lumped together for analysis.

3 Results

3.1 Target invasive exotic plant list

Twenty-six IEP species were identified as Priority 1 for the GOSP target IEP list (Appendix A). An additional 6 and 14 species were identified as Priority 2 and 3 species, respectively, for a total target list of 46 species.

A total of 25 IEP species were recorded on monitoring routes and in plots (Table 3.1). Six IEP species were recorded on monitoring routes and 20 were recorded in monitoring plots (one species, field bindweed, was recorded both along routes and in plots). Of the 25 IEP species detected, six were Priority 1, one was Priority 2, seven were Priority 3, and 11 were not identified as priority species (Table 3.1).

3.2 Monitoring routes

A total of 26.7 km (16.6 miles) were walked along 12 monitoring routes for a total area of 109.1 ha (269.5 acres) surveyed (see Figures 3.3-1 and 3.3-2). Seven of the monitoring routes were shorter than 1 km.

A total of 100 infestations of six different Priority 1 species were detected along the monitoring routes (Table 3.2-1, Appendix B). Field bindweed, Dyer's woad (*Isatis tinctoria*), and Scotch thistle (*Onopordum acanthium*) were the most common invasive exotic plants detected. Although only a relatively short length of riparian habitat was monitored, it had more infestations per 100 m than were detected along roads (Table 3.2-1). Of

the 100 infestations, 63% were classified as infestations in either the "1–a few plants" (1) or "few plants–40 m²" (2) size classes. Table 3.2-2 lists the size of each infestation detected by species.

3.3 Monitoring plots

A total of 39 plots were sampled (Figures 3.3-1 and 3.3-2, Table 3.3, Appendix C). The results presented here focus on cover in nested quadrats.

All known IEP species for GOSP were detected on the monitoring plots, and IEP species were present in 100% of the plots, with an average of 2.49 IEP species detected per plot. *Bromus* spp. were the most widespread IEP taxons, present in 87% of the plots and with a mean canopy cover of 14% across all plots (Table 3.3). Redstem storksbill (*Erodium cicutarium*), crested wheatgrass (*Agropyron cristatum*), and tall tumbled mustard (*Sisymbrium altissimum*) were the next most prevalent species, present in 51%, 31%, and 23% of the plots, respectively. Crested wheatgrass was much more prevalent at the Last Spike administrative area (21% cover) than the Big Fill area (0.1 % cover), while redstem storksbill was more prevalent in the Big Fill area (7.3% cover) than the Last Spike administrative area (0.1% cover). All other species were present in less than 10% of the plots. Yellow sweetclover (*Melilotus officinalis*) and African mustard (*Malcolmia africana*) were only detected along the Last Cut Drainage route in the Big Fill area (Table 3.3). Matrimony vine (*Lycium barbarum*) and a few other plants were detected on the plot walk performed outside the nested quadrats.

Table 3.1. List of invasive exotic plants recorded, Golden Spike NHS, July 12–13, 2008.

Scientific name	Common name	Method detected		Park priority
		Routes	Plots	
<i>Carduus nutans</i>	musk thistle	X		1
<i>Cirsium arvense</i>	Canada thistle	X		1
<i>Convolvulus arvensis</i>	field bindweed	X	X	1
<i>Isatis tinctoria</i>	Dyer's woad	X		1
<i>Marrubium vulgare</i>	common horehound	X		1
<i>Onopordum acanthium</i>	Scotch thistle	X		1
<i>Tragopon dubius</i>	goatsbeard		X	2
<i>Agropyron cristatum</i>	crested wheatgrass		X	3
<i>Bromus japonicus</i>	Japanese brome		X	3
<i>Bromus tectorum</i>	cheatgrass		X	3
<i>Descurainia sophia</i>	flixweed		X	3
<i>Malcolmia africana</i>	African mustard		X	3
<i>Melilotus officinalis</i>	yellow sweetclover		X	3
<i>Salsola tragus</i>	Russian thistle		X	3
<i>Alyssum alyssoides</i>	pale madwort		X	Not on list
<i>Atriplex rosea</i>	tumbling saltweed		X	Not on list
<i>Bromus briziformis</i>	rattlesnake brome		X	Not on list
<i>Elymus elongatus</i>	tall wheatgrass		X	Not on list
<i>Erodium cicutarium</i>	redstem storksbill		X	Not on list
<i>Lactuca serriola</i>	prickly lettuce		X	Not on list
<i>Lepidium perfoliatum</i>	clasping pepperweed		X	Not on list
<i>Lycium barbarum</i>	matrimony vine		X	Not on list
<i>Poa bulbosa</i>	bulbous bluegrass		X	Not on list
<i>Polygonum aviculare</i>	prostrate knotweed		X	Not on list
<i>Sisymbrium altissimum</i>	tall tumbled mustard		X	Not on list

Table 3.2-1. Number of IEP infestations per route surveyed, Golden Spike NHS, July 12–13, 2008.

Route	Type of route	Length (m)	Infestations	Infestations/100 m
Hydro 1	Riparian	295	4	1.36
Last Cut Drainage	Riparian	1,684	30	1.78
East Tour Road	Road	5,260	27	0.51
Facility Road	Road	638	3	0.47
Big Fill Section County Rd	Road	2,568	10	0.39
County Road	Road	1080	14	1.30
Water Tank Road	Road	447	1	0.22
Residence Service Road	Road	164	2	1.22
Witkers Service Road	Road	464	0	0.00
Retired Service Road	Road	260	2	0.80
Polsoms Road	Road	2,067	5	0.24
Pacific Track Grade	Road	998	2	0.20
<i>All riparian</i>		<i>1,979</i>	<i>34</i>	<i>1.72</i>
<i>All roads</i>		<i>13,946</i>	<i>66</i>	<i>0.47</i>
All routes		15,925	100	0.63

Table 3.2-2. Size of infestation detected for Priority 1 species along monitoring routes, Golden Spike NHS, July 12–13, 2008.

Scientific name	Common name	Infestation size class Number of infestations					Total infestations
		1	2	3	4	5	
<i>Carduus nutans</i>	musk thistle	1	1	0	0	0	2
<i>Cirsium arvense</i>	Canada thistle	0	0	1	0	0	1
<i>Convolvulus arvensis</i>	field bindweed	5	15	14	5	2	41
<i>Isatis tinctoria</i>	Dyer's woad	20	4	3	1	0	28
<i>Marrubium vulgare</i>	white horehound	1	0	1	0	0	2
<i>Onopordum acanthium</i>	Scotch thistle	8	8	10	0	0	26
All species		35	28	29	6	2	100

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)

Golden Spike NHS Weed Monitoring 2008 Big Fill area

Species name, infestation size class

- | | |
|------------------------|----------------------|
| ● Canada thistle (1) | ● Field bindweed (3) |
| ● Common horehound (1) | ● Field bindweed (4) |
| ● Common horehound (2) | ● Field bindweed (5) |
| ○ Dyer's woad (1) | ○ Musk thistle (1) |
| ○ Dyer's woad (2) | ● Musk thistle (2) |
| ○ Dyer's woad (3) | ○ Scotch thistle (1) |
| ● Dyer's woad (4) | ● Scotch thistle (2) |
| ○ Field bindweed (1) | ● Scotch thistle (3) |
| ● Field bindweed (2) | |

Surveyed monitoring route

- Big Fill section county road
- East Tour Road
- Last Cut Drainage
- Polesoms Road
- △ Monitoring plot

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

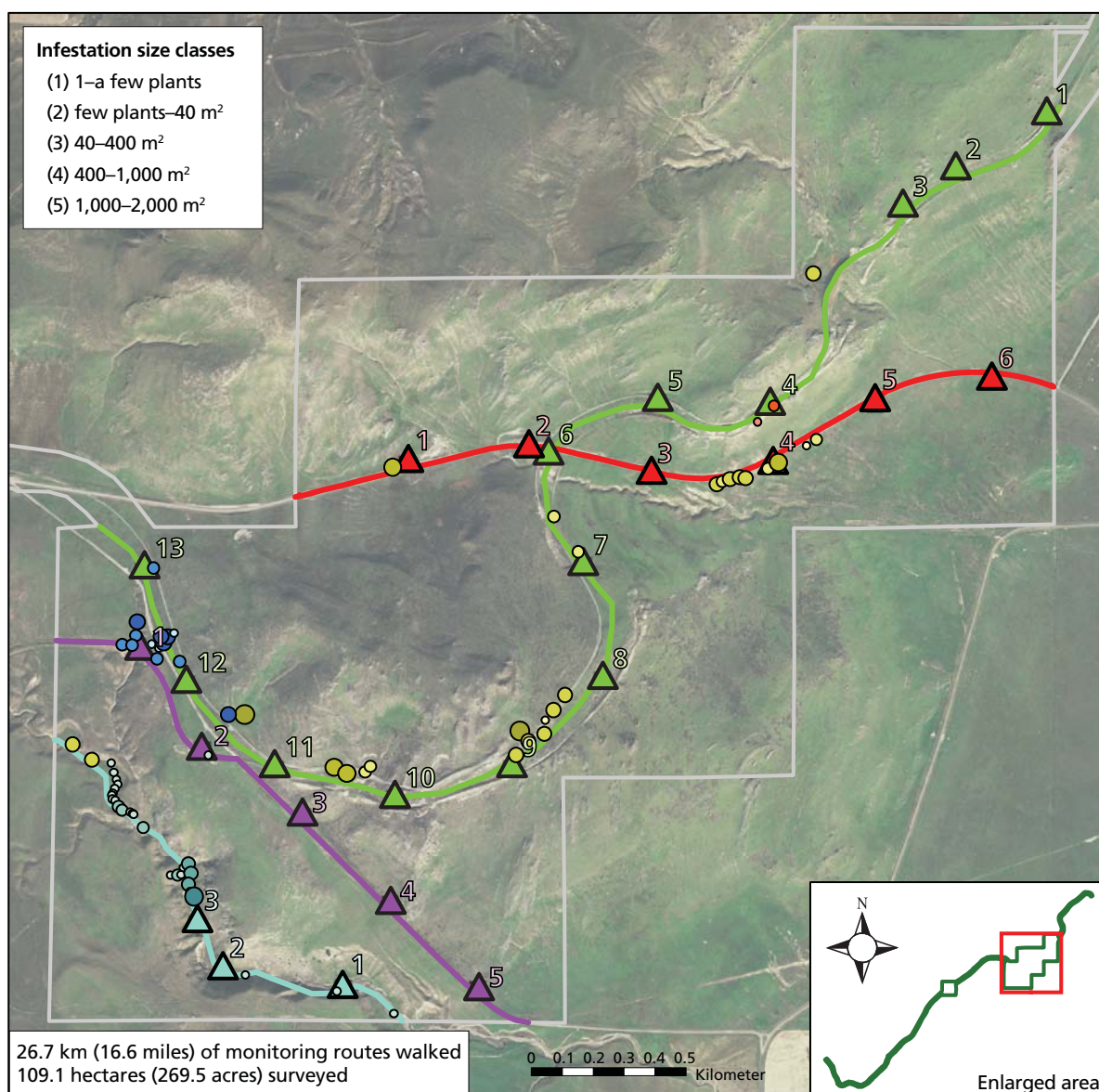


Figure 3.3-1. Invasive plant monitoring routes, monitoring plots, and invasives detected along monitoring routes, Big Fill area, Golden Spike NHS, July 12–13, 2008.

Golden Spike NHS Weed Monitoring 2008 Last Spike administrative area

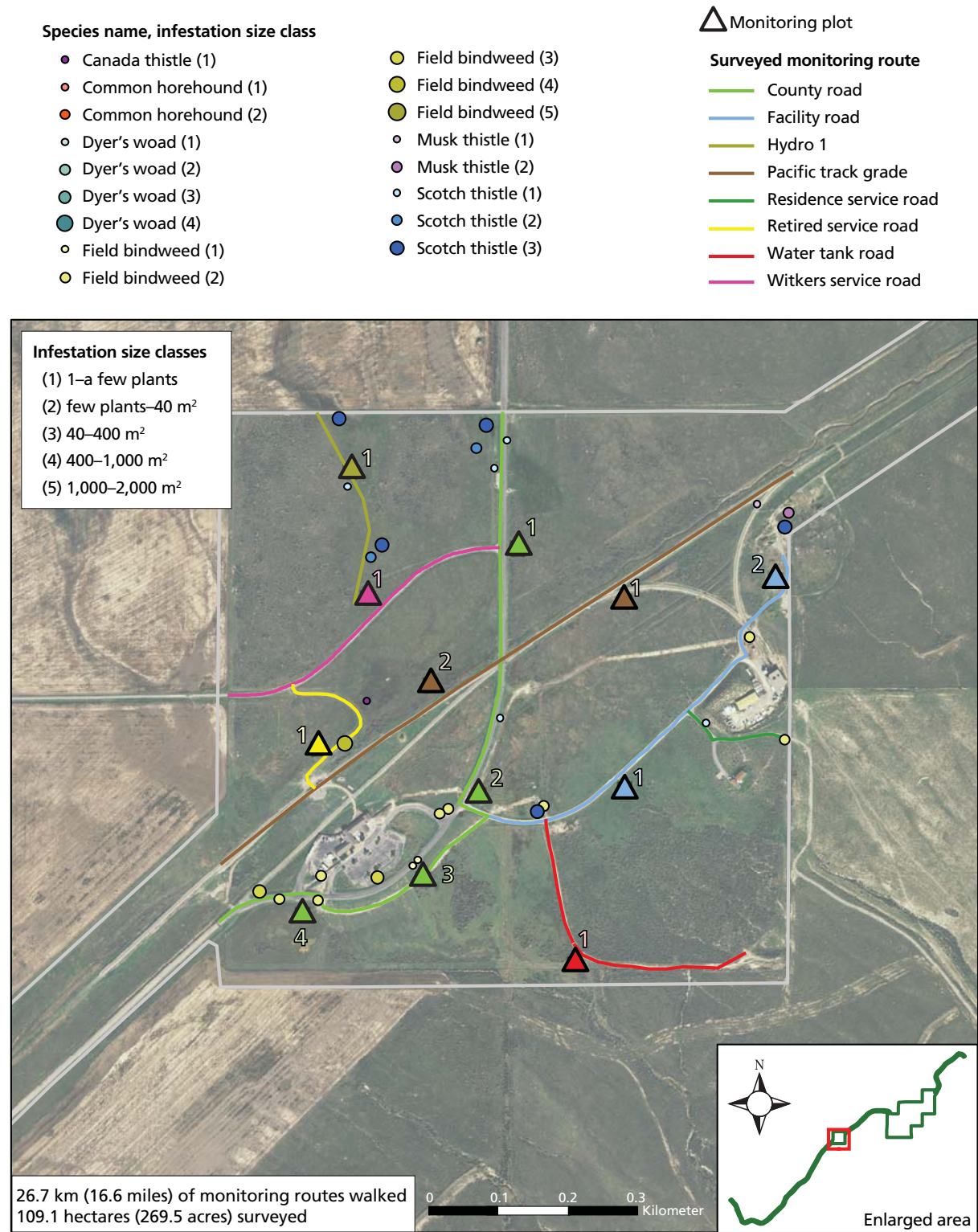


Figure 3.3-2. Invasive plant monitoring routes, monitoring plots, and invasives detected along monitoring routes, Last Spike administrative area, Golden Spike NHS, July 12–13, 2008.

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), Golden Spike NHS, July 12–13, 2008.

Scientific name	Common name	LS Area (12) # of plots % cover (SE)	Big Fill (27) # of plots % cover (SE)	ETR (13) # of plots % cover (SE)	BFSC (6) # of plots % cover (SE)	PORO (5) # of plots % cover (SE)	CORO (4) # of plots % cover (SE)
<i>Agropyron cristatum</i>	crested wheatgrass	11 20.5 (16.6)	1 0.1 (0.3)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)	4 24.6 (17.1)
<i>Alyssum alyssoides</i>	pale alyssum	0 0.0 (0.0)	2 0.1 (0.3)	2 0.1 (0.4)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)
<i>Atriplex rosea</i>	redscale saltbush	1 0.1 (0.5)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)
<i>Bromus briziformis</i>	rattlesnake brome	0 0.0 (0.0)	2 0.02 (0.1)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)
<i>Bromus tectorum</i>	cheatgrass	7 9.0 (21.1)	27 16.2 (14.7)	13 9.0 (5.4)	6 31.0 (12.7)	5 26.3 (17.4)	2 0.3 (0.4)
<i>Convolvulus arvensis</i>	field bindweed	0 0.0 (0.0)	1 0.5 (2.3)	0 0.0 (0.0)	1 2.0 (5.0)	0 0.0 (0.0)	0 0.0 (0.0)
<i>Descurainia sophia</i>	flixweed	2 0.5 (1.2)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)	1 0.9 (1.8)
<i>Elymus elongatus</i>	tall wheatgrass	0 0.0 (0.0)	1 0.1 (0.6)	0 0.0 (0.0)	1 0.6 (1.4)	0 0.0 (0.0)	0 0.0 (0.0)
<i>Erodium cicutarium</i>	redstem storksbill	1 0.1 (0.2)	19 7.3 (8.2)	12 10.6 (8.3)	5 8.6 (6.9)	2 1.4 (2.8)	0 0.0 (0.0)
<i>Lactuca serriola</i>	prickly lettuce	1 0.03 (0.1)	1 0.01 (0.1)	1 0.03 (0.1)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)
<i>Lepidium perfoliatum</i>	clasping pepperweed	1 0.5 (1.7)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)
<i>Malcolmia africana</i>	African mustard	0 0.0 (0.0)	1 0.01 (0.1)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)
<i>Melilotus officinalis</i>	yellow sweetclover	0 0.0 (0.0)	2 0.2 (1.2)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)
<i>Poa bulbosa</i>	bulbous bluegrass	0 0.0 (0.0)	4 0.1 (0.4)	1 0.1 (0.5)	0 0.0 (0.0)	2 0.2 (0.4)	0 0.0 (0.0)
<i>Polygonum aviculare</i>	prostrate knotweed	1 0.03 (0.1)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)
<i>Salsola tragus</i>	Russian thistle	1 0.1 (0.5)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)	1 0.4 (0.8)
<i>Sisymbrium altissimum</i>	tall tumbled mustard	5 4.3 (8.6)	4 0.1 (0.3)	3 0.2 (0.4)	1 0.1 (0.3)	0 0.0 (0.0)	1 5.6 (11.1)
<i>Tragopon dubius</i>	goatsbeard	1 0.03 (0.1)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)	0 0.0 (0.0)

Total number of plots per area or route are listed in parentheses in the header row. LS = Last Spike administrative area; ETR = East Tour Road; BFSC = Big Fill Section County Road; PORO = Polsons Road; CORO = County Road.

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.

4.2 Target IEP list

The methods used to determine the target IEP list for GOSP adequately covered the species of management concern that were actually detected. Due to its prevalence and difficulty of control, we recommend that field bindweed be removed from the target IEP list at GOSP. Field bindweed could be continued to be monitored on plots, but not during monitoring routes.

4.3 Possibilities for management control

Exotic plants are widespread at GOSP, with at least one IEP detected in 100% of monitoring plots. Four taxa, crested wheatgrass, brome, field bindweed, and redstem storksbill, are widespread and may be beyond management control. Both units of GOSP have large areas of infestation by brome species, which was present in 87% of the plots. Field bindweed and redstem storksbill were widespread in the Big Fill section, while crested wheatgrass was widespread in the Last Spike administrative area.

However, 63% of infestations by species detected on monitoring routes were less than 40 m² in size, indicating that rapid control of these infestations

may limit their expansion and minimize additional widespread invasions of IEP species at GOSP. Species that are not yet well-established and may be possible to control are Canada thistle (*Cirsium arvense*), Scotch thistle, and musk thistle (*Carduus nutans*). Small patches of white horehound (*Marrubium vulgare*) were detected along the East Tour Road, north of the Big Fill section of County Road, well away from cultivated areas. This species can become aggressive and should be controlled before it spreads from this area. Dyer's woad was mostly found along the Last Cut Drainage route in the Big Fill section, where it was widespread. However, because only one individual plant of this species was recorded anywhere else in the park, it may still be controllable. Additional suggestions for which species might be controlled should be made by the Northern Rockies Exotic Plant Management Team upon review of this report. 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.

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 repeat these surveys in 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 by monitoring routes.

4.5 New species

During this field season, the NCPN recorded seven new species for GOSP. The following five species were collected and deposited at the Utah State University herbarium: antelope bitterbrush (*Purshia tridentata*, UTC #249912), winterfat (*Kr-*

ascheninnikovia lanata, UTC#249913), grease-wood (*Sarcobatus vermiculatus*, UTC#249914), jointed goatgrass (*Aegilops cylindrica*, UTC#249915), and lemon scurfpea (*Psoraleidium lanceolatum*, UTC#249916). Two new species were

recorded but not collected: intermediate wheat-grass (*Elymus hispidus*) and clasping pepperweed (*Lepidium perfoliatum*). GOSP staff requested that we look for populations of the rare Passey's onion (*Allium passeyi*), but none was observed.

5 Literature Cited

- Andersen, K. A., and S. A. Dewey. 2007. USU wildland weed mapping methods training supplement. Master's thesis. Utah State University, Logan, Ut. 107 pp. plus appendix.
- Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 1998. Measuring and monitoring plant populations. USDI-BLM Technical Ref. 1730-1. 477 pp.
- Mooney, H., and R. J. Hobbs, eds. Invasive species in a changing world. Washington, D.C.: Island Press. 457 pp.
- National Research Council. 2002. Predicting invasions of nonindigenous plants and plant pests. Washington, D.C.: National Academy of Sciences.
- O'Dell, T., S. Garman, A. Evenden, M. Beer, E. Nance, D. Perry, R. DenBleyker, et al. 2005. Northern Colorado Plateau Inventory and Monitoring Network vital signs monitoring plan. Moab, Ut.: National Park Service. 174 pp. plus appendices.
- Scott, J. M., and D. S. Wilcove. 1998. Improving the future for endangered species. *BioScience* 48(8):579–580.
- Stohlgren, T. J., D. T. Barnett, and S. E. Simonson. 2005. Beyond North American Weed Management Association standards. <http://www.nawma.org/documents/Mapping%20Standards/BEYOND%20NAWMA%20STANDARDS.pdf>. Last accessed January 13, 2008.

Appendix A. Golden Spike National Historic Site target invasive exotic plant list.

Scientific name	Common name	Scientific name	Common name
Priority 1		Priority 3	
1 <i>Agropyron repens/</i> <i>Elymus repens</i>	quackgrass	1 <i>Agropyron cristatum</i>	crested wheatgrass
2 <i>Cardaria chalepensis</i>	lens-podded whitetop	2 <i>Bromus japonicus</i>	Japanese brome
3 <i>Cardaria draba</i>	hoary cress	3 <i>Bromus tectorum</i>	downy brome/cheatgrass
4 <i>Cardaria pubescens</i>	whitetop	4 <i>Descurainia sophia</i>	flixweed
5 <i>Carduus nutans</i>	musk thistle	5 <i>Dipsacus sylvestris</i>	teasel
6 <i>Centaurea diffusa</i>	diffuse knapweed	6 <i>Halogeton</i> <i>glomeratus</i>	halogeton
7 <i>Centaurea maculosa</i>	spotted knapweed	7 <i>Hyoscyamus niger</i>	black henbane
8 <i>Centaurea repens</i>	Russian knapweed	8 <i>Kochia scoparia</i>	kochia
9 <i>Centaurea solstitialis</i>	yellow starthistle	9 <i>Malcomia africana</i>	African mustard
10 <i>Centaurea squarrosa</i>	squarrose knapweed	10 <i>Melilotus officinalis</i>	yellow sweetclover
11 <i>Cirsium arvense</i>	Canada thistle	11 <i>Phleum pratense</i>	timothy
12 <i>Condrilla juncea</i>	rush skeltonweed	12 <i>Rumex crispus</i>	curly dock
13 <i>Convolvulus arvensis</i>	field bindweed	13 <i>Salsola tragus</i>	Russian thistle
14 <i>Crupina vulgaris</i>	common crupina	14 <i>Verbascum thapsus</i>	common mullein
15 <i>Euphorbia esula</i>	leafy spurge		
16 <i>Hypericum</i> <i>perforatum</i>	common St. Johnswort		
17 <i>Isatis tinctoria</i>	Dyer's woad		
18 <i>Lepidium latifolium</i>	perennial pepperweed		
19 <i>Linaria dalmatica</i>	Dalmatian toadflax		
20 <i>Marrubium vulgare</i>	white horehound		
21 <i>Onopordum</i> <i>acanthium</i>	Scotch thistle		
22 <i>Salvia aethiopsis</i>	Mediterranean sage		
23 <i>Senecio jacobaea</i>	tansy ragwort		
24 <i>Taeniatherum caput-</i> <i>medusae</i>	Medusahead rye		
25 <i>Tribulus terrestris</i>	puncturevine		
26 <i>Verbascum blattaria</i>	moth mullein		
Priority 2			
1 <i>Arctium minus</i>	common burdock		
2 <i>Chrysanthemum</i> <i>leucaanthemum</i>	oxeye daisy		
3 <i>Cynoglossum</i> <i>officinale</i>	houndstongue		
4 <i>Sonchus arvensis/</i> <i>S. ulginosis</i>	perennial sowthistle		
5 <i>Tamarix ramosissima</i>	saltcedar		
6 <i>Tragopogon dubius</i>	goatsbeard		

Appendix B. List of all exotic plant invasions detected on monitoring routes, Golden Spike NHS, July 12–13, 2008.

Monitoring route	Scientific name	Common name	Infestation size class	Canopy cover class	Northing	Easting
Big Fill area						
East Tour Road	<i>Marrubium vulgare</i>	common horehound	3	4	4610606.516	376545.821
			1	5	4610657.395	376611.229
	<i>Convolvulus arvensis</i>	field bindweed	5	3	4609657.9	374884.968
			4	3	4609487.677	375175.065
			4	3	4609468.205	375216.693
			2	2	4609472.005	375275.304
			2	2	4609490.145	375292.675
			3	3	4609540.626	375754.701
			5	3	4609605.354	375776.204
			3	2	4609572.92	375804.460
			3	2	4609595.965	375856.520
			1	5	4609639.495	375858.327
			2	3	4610299.36	375886.165
			2	3	4610196.803	375965.514
			3	3	4609673.391	375885.478
			3	3	4609722.28	375922.913
			3	3	4611086.489	376725.919
	<i>Onopordum acanthium</i>	Scotch thistle	3	3	4609963.482	374543.158
			1	5	4609887.338	374584.428
			1	5	4609873.948	374608.117
			3	1	4609658.907	374833.290
			2	1	4609830.619	374675.682
			3	1	4609892.051	374623.856
			3	1	4609909.371	374637.034
			3	1	4609910.421	374615.784
			1	5	4609922.09	374656.528
			2	1	4610145.756	374580.762
Big Fill Sect. County Rd	<i>Convolvulus arvensis</i>	field bindweed	4	3	4610471.843	375365.834
			3	3	4610402.671	376413.291
			2	3	4610412.182	376432.153
			3	3	4610419.786	376456.620
			3	3	4610425.607	376488.755
			3	3	4610423.574	376507.413
			2	3	4610463.709	376592.127
			4	3	4610483.311	376626.279
			1	3	4610527.600	376704.735
			2	3	4610548.219	376736.744
Last Cut Drainage	<i>Isatis tinctoria</i>	Dyer's woad	1	2	4608815.332	374888.057
			1	3	4608769.867	375190.055
			1	1	4608690.553	375368.088
			1	3	4609512.956	374387.224
			1	1	4609501.426	374454.035

Appendix B. List of all exotic plant invasions detected on monitoring routes, Golden Spike NHS, July 12–13, 2008, cont.

Monitoring route	Scientific name	Common name	Infestation size class	Canopy cover class	Northing	Easting
Big Fill area, cont.						
Last Cut Drainage	Isatis tinctoria	Dyer's woad	1	3	4609470.740	374462.073
			1	3	4609448.127	374470.225
			1	2	4609433.138	374475.844
			1	2	4609418.751	374464.719
			1	2	4609403.028	374459.264
			1	2	4609397.066	374455.856
			1	3	4609385.472	374456.541
			1	3	4609380.687	374466.649
			2	2	4609361.227	374476.780
			2	2	4609349.017	374488.911
			1	2	4609342.650	374514.448
			1	3	4609337.814	374522.935
			1	2	4609334.904	374526.468
			2	2	4609292.895	374557.538
			1	2	4609138.876	374646.494
			2	2	4609138.239	374668.483
			1	3	4609140.007	374679.610
			1	2	4609162.749	374686.656
			3	2	4609174.597	374704.632
			3	2	4609145.284	374712.146
			3	2	4609109.690	374703.871
			4	4	4609069.261	374722.851
	Convolvulus arvensis	field bindweed	3	4	4609561.509	374328.621
			3	3	4609511.381	374391.471
			1	2	4609084.470	374708.939
Polsoms Road	Isatis tinctoria	Dyer's woad	1	5	4609521.427	374760.025
			Onopordum acanthium	Scotch thistle	2	2
	2	2	4609844.119		374606.341	
	2	1	4609889.069		374493.320	
	2	1	4609888.945		374525.073	
Last Spike administrative area						
Facility Road	Convolvulus arvensis	field bindweed	2	4	4608738.076	371357.825
	Onopordum acanthium	Scotch thistle	3	3	4608895.545	371408.519
	3		3	4608487.457	371053.418	
County Road	Onopordum acanthium	Scotch thistle	1	3	4609020.089	371009.458
			3	2	4609042.188	370980.036
			2	3	4609008.939	370965.610
			1	3	4608980.542	370991.804
			1	3	4608621.796	371000.169
	Convolvulus arvensis	field bindweed	2	4	4608361.596	370682.894
			2	3	4608359.860	370739.053
			1	2	4608410.049	370874.783
			1	5	4608417.870	370881.796

Appendix B. List of all exotic plant invasions detected on monitoring routes, Golden Spike NHS, July 12–13, 2008, cont.

Monitoring route	Scientific name	Common name	Infestation size class	Canopy cover class	Northing	Easting
<i>Last Spike administrative area, cont.</i>						
County Road	<i>Convolvulus arvensis</i>	field bindweed	2	3	4608491.255	370925.393
			2	3	4608484.122	370912.846
			3	4	4608393.313	370824.282
			2	3	4608395.388	370742.919
			3	4	4608373.018	370654.966
Hydro 1	<i>Onopordum acanthium</i>	Scotch thistle	3	1	4608870.083	370830.563
			2	1	4608852.526	370814.638
			1	5	4608953.921	370780.751
			3	3	4609051.157	370769.071
Pacific Track Grade	<i>Carduus nutans</i>	musk thistle	2	3	4608916.434	371413.730
			1	3	4608928.770	371368.503
Water Tank Road	<i>Convolvulus arvensis</i>	field bindweed	2	4	4608495.663	371062.542
Residence Service Road	<i>Convolvulus arvensis</i>	field bindweed	2	3	4608590.663	371408.558
	<i>Onopordum acanthium</i>	Scotch thistle	1	4	4608614.826	371295.321
Retired Service Road	<i>Cirsium arvense</i>	Canada thistle	3	5	4608646.185	370808.573
	<i>Convolvulus arvensis</i>	field bindweed	4	2	4608584.987	370777.649

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, Golden Spike NHS, July 12–13, 2008.

Route-Plot	Area	Scientific name	Common name	Mean cover	Easting	Northing
ETR-1	Big Fill	<i>Bromus tectorum</i>	cheatgrass	8.33	4611596.990	377478.777
		<i>Erodium cicutarium</i>	redstem storksbill	13.00		
		<i>Poa bulbosa</i>	bulbous bluegrass	1.83		
ETR-2	Big Fill	<i>Bromus tectorum</i>	cheatgrass	2.00	4611414.833	377186.738
		<i>Erodium cicutarium</i>	redstem storksbill	4.33		
ETR-3	Big Fill	<i>Bromus tectorum</i>	cheatgrass	14.67	4611298.298	377014.099
		<i>Erodium cicutarium</i>	redstem storksbill	24.67		
ETR-4	Big Fill	Too steep for plot				
ETR-5	Big Fill	<i>Bromus tectorum</i>	cheatgrass	4.50	4610658.093	376589.705
		<i>Erodium cicutarium</i>	redstem storksbill	12.00		
ETR-6	Big Fill	<i>Bromus tectorum</i>	cheatgrass	2.00	4610670.036	376220.237
		<i>Erodium cicutarium</i>	redstem storksbill	18.00		
ETR-7	Big Fill	<i>Bromus tectorum</i>	cheatgrass	2.67	4610496.998	375862.747
		<i>Erodium cicutarium</i>	redstem storksbill	21.33		
		<i>Sisymbrium altissimum</i>	tall tumbled mustard	1.00		
ETR-8	Big Fill	<i>Bromus tectorum</i>	cheatgrass	11.00	4610139.641	375979.698
ETR-9	Big Fill	<i>Bromus tectorum</i>	cheatgrass	18.00	4609771.415	376040.432
		<i>Erodium cicutarium</i>	redstem storksbill	13.00		
		<i>Sisymbrium altissimum</i>	tall tumbled mustard	1.33		
ETR-10	Big Fill	<i>Bromus tectorum</i>	cheatgrass	11.33	4609484.218	375746.058
		<i>Erodium cicutarium</i>	redstem storksbill	12.67		
ETR-11	Big Fill	<i>Alyssum alyssoides</i>	pale alyssum	0.33	4609386.821	375369.299
		<i>Bromus tectorum</i>	cheatgrass	5.33		
		<i>Erodium cicutarium</i>	redstem storksbill	0.33		
ETR-12	Big Fill	<i>Bromus tectorum</i>	cheatgrass	15.00	4609482.004	374984.959
		<i>Erodium cicutarium</i>	redstem storksbill	2.83		
ETR-13	Big Fill	<i>Bromus tectorum</i>	cheatgrass	9.33	4609757.518	374696.430
		<i>Erodium cicutarium</i>	redstem storksbill	15.17		
		<i>Sisymbrium altissimum</i>	tall tumbled mustard	0.17		
ETR-14	Big Fill	<i>Alyssum alyssoides</i>	pale alyssum	1.33	4610126.993	374558.017
		<i>Bromus tectorum</i>	cheatgrass	13.33		
		<i>Erodium cicutarium</i>	redstem storksbill	0.67		
		<i>Lactuca serriola</i>	prickly lettuce	0.33		
HYD1-1	Last Spike	<i>Agropyron cristatum</i>	crested wheatgrass	46.33	4608975.903	370785.349
FARO-1	Last Spike	<i>Bromus tectorum</i>	cheatgrass	71.33	4608519.801	371177.871
		<i>Sisymbrium altissimum</i>	tall tumbled mustard	3.67		
FARO-2	Last Spike	<i>Agropyron cristatum</i>	crested wheatgrass	7.67	4608821.050	371393.857
		<i>Bromus tectorum</i>	cheatgrass	27.00		
		<i>Sisymbrium altissimum</i>	tall tumbled mustard	22.67		
BFSC-1	Big Fill	<i>Bromus tectorum</i>	cheatgrass	48.00	4610470.003	375409.829
		<i>Erodium cicutarium</i>	redstem storksbill	24.67		
BFSC-2	Big Fill	<i>Bromus tectorum</i>	cheatgrass	18.00	4610518.833	375804.995
BFSC-3	Big Fill	<i>Bromus tectorum</i>	cheatgrass	33.00	4610436.098	376195.183

Appendix C. Invasive exotic plant percent cover detected by monitoring plot, Golden Spike NHS, July 12–13, 2008, cont.

Route-Plot	Area	Scientific name	Common name	Mean cover	Easting	Northing
BFSC-3	Big Fill	<i>Erodium cicutarium</i>	redstem storksbill	12.33		
		<i>Elymus elongatus</i>	tall wheatgrass	3.33		
BFSC-4	Big Fill	<i>Bromus tectorum</i>	cheatgrass	14.67	4610467.499	376597.221
		<i>Convolvulus arvensis</i>	field bindweed	12.17		
		<i>Erodium cicutarium</i>	redstem storksbill	8.33		
BFSC-5	Big Fill	<i>Bromus tectorum</i>	cheatgrass	39.67	4610664.645	376924.743
		<i>Erodium cicutarium</i>	redstem storksbill	3.00		
BFSC-6	Big Fill	<i>Bromus tectorum</i>	cheatgrass	32.83	4610742.675	377304.162
		<i>Erodium cicutarium</i>	redstem storksbill	3.33		
		<i>Sisymbrium altissimum</i>	tall tumbledmustard	0.67		
CORO-1	Last Spike	<i>Agropyron cristatum</i>	crested wheatgrass	28.00	4608865.553	371024.211
		<i>Bromus tectorum</i>	cheatgrass	0.17		
CORO- 2	Last Spike	<i>Agropyron cristatum</i>	crested wheatgrass	46.33	4608510.783	370968.675
CORO-3	Last Spike	<i>Agropyron cristatum</i>	crested wheatgrass	6.00	4608393.084	370888.851
		<i>Bromus tectorum</i>	cheatgrass	0.83		
		<i>Descurainia sophia</i>	flixweed	3.67		
		<i>Polygonum aviculare</i>	prostrate knotweed	0.33		
		<i>Salsola tragus</i>	Russian thistle	1.67		
		<i>Sisymbrium altissimum</i>	tall tumbledmustard	22.33		
CORO-4	Last Spike	<i>Agropyron cristatum</i>	crested wheatgrass	18.00	4608339.996	370716.492
LCD-1	Big Fill	<i>Bromus briziformis</i>	rattlesnake brome	0.33	4608775.679	375203.189
		<i>Bromus tectorum</i>	cheatgrass	0.33		
		<i>Malcolmia africana</i>	African mustard	0.33		
		<i>Melilotus officinalis</i>	yellow sweetclover	0.50		
		<i>Poa bulbosa</i>	bulbous bluegrass	0.17		
LCD-2	Big Fill	<i>Agropyron cristatum</i>	crested wheatgrass	1.67	4608830.862	374812.650
		<i>Bromus tectorum</i>	cheatgrass	1.33		
		<i>Melilotus officinalis</i>	yellow sweetclover	6.00		
LCD-3	Big Fill	<i>Bromus briziformis</i>	rattlesnake brome	0.33	4608983.728	374730.101
		<i>Bromus tectorum</i>	cheatgrass	0.50		
PTG-1	Last Spike	<i>Agropyron cristatum</i>	crested wheatgrass	23.67	4608790.927	371177.843
		<i>Bromus tectorum</i>	cheatgrass	0.67		
PTG-2	Last Spike	<i>Agropyron cristatum</i>	crested wheatgrass	6.67	4608669.369	370899.672
		<i>Atriplex rosea</i>	redscale saltbush	2.67		
		<i>Bromus tectorum</i>	cheatgrass	2.33		
		<i>Descurainia sophia</i>	flixweed	2.67		
		<i>Sisymbrium altissimum</i>	tall tumbledmustard	0.17		
		<i>Tragopogon dubius</i>	goatsbeard	0.33		
WTRO-1	Last Spike	<i>Agropyron cristatum</i>	crested wheatgrass	0.83	4608269.742	371106.371
		<i>Bromus tectorum</i>	cheatgrass	5.67		
		<i>Erodium cicutarium</i>	redstem storksbill	0.67		
		<i>Lactuca serriola</i>	prickly lettuce	0.33		
		<i>Lepidium perfoliatum</i>	clasping pepperweed	6.00		
		<i>Sisymbrium altissimum</i>	tall tumbledmustard	2.33		

Appendix C. Invasive exotic plant percent cover detected by monitoring plot, Golden Spike NHS, July 12–13, 2008, cont.

Route-Plot	Area	Scientific name	Common name	Mean cover	Easting	Northing
WSRO-1	Last Spike	<i>Agropyron cristatum</i>	crested wheatgrass	31.33	4608795.313	370809.401
RSRO-1	Last Spike	<i>Agropyron cristatum</i>	crested wheatgrass	31.33	4608579.422	370738.727
PORO-5	Big Fill	<i>Bromus tectorum</i>	cheatgrass	33.00	4608770.744	375638.746
		<i>Erodium cicutarium</i>	redstem storksbill	0.67		
PORO-4	Big Fill	<i>Bromus tectorum</i>	cheatgrass	48.00	4609045.319	375355.069
		<i>Poa bulbosa</i>	bulbous bluegrass	0.83		
PORO-3	Big Fill	<i>Bromus tectorum</i>	cheatgrass	33.67	4609330.729	375072.207
		<i>Poa bulbosa</i>	bulbous bluegrass	0.33		
PORO-2	Big Fill	<i>Bromus tectorum</i>	cheatgrass	8.00	4609547.065	374747.570
		<i>Erodium cicutarium</i>	redstem storksbill	6.33		
PORO-1	Big Fill	<i>Bromus tectorum</i>	cheatgrass	8.83	4609866.804	374547.918

ETR = East Tour Road; HYD1 = Hydro 1; LCD = Last Cut Drainage; FARO = Facility Road; BFSC = Big Fill Section Country Road; PORO = Polsoms Road; CORO = County Road; PTG = Pacific Track Grade; WTRO = Water Tank Road; WSRO = Witkers Service Road; RSRO = Retired Service Road.

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.

NPS 431/100143, July 2009

National Park Service
U.S. Department of the Interior



Natural Resource Program Center

1201 Oak Ridge Drive, Suite 150
Fort Collins, Colorado 80525

www.nature.nps.gov