



Invasive Exotic Plant Monitoring in Golden Spike National Historic Site

2012 Field Season

Natural Resource Technical Report NPS/NCPN/NRTR—2013/748



ON THE COVER

Big Fill area, Golden Spike National Historic Site. National Park Service/A. Wondrak Biel.

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Abstract

Invasive exotic plant (IEP) species are one of the biggest threats to natural ecosystem integrity and biodiversity, and controlling them is a high priority for the National Park Service. The Northern Colorado Plateau Network (NCPN) selected the early detection of IEPs as one of 10 monitoring protocols to be implemented as part of its long-term monitoring program. This report represents work completed during the 2012 field season at Golden Spike National Historic Site (GOSP). On August 7–8, 2012, two priority IEP species were detected on monitoring routes and plots that covered all major roads, trails, and riparian areas at GOSP. Exotic control work by NPS staff has drastically reduced the number of infestations of priority IEPs from 59 in 2008, and 46 in 2010, to just 6 in 2012. Due to the drastic reduction in the number of priority IEPs, the park may want to consider expanding the list of species that is monitored and controlled, as there are still a number of other IEPs present at GOSP that are not on the priority list. The priority infestations that were detected are present in small, localized invasions that have a good chance of being successfully controlled through management actions. The network will return to GOSP for a fourth year of monitoring in 2014.

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D. Block and J. Doucette conducted field work. A. Wight was extremely helpful in generating routes, quadrats, and other GIS information. T. Benson assisted with reviewing the park target invasive plant list and arranging site logistics. D. Witwicki and T. Benson improved this report with their thoughtful review. Data management was provided by H. Thomas. R. Weissinger and D. Perry assisted with logistical and administrative details.

1 Introduction

Invasive exotic species fragment native ecosystems, displace native plants and animals, and alter ecosystem function. Invasive species are 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 (NRC 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, 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 target IEPs in parks along key invasive pathways.

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

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

Specific objectives of NCPN invasive exotic plant monitoring are:

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

This report summarizes the 2012 field season and third complete monitoring visit at Golden Spike National Historic Site (NHS).

2 Methods

We followed the invasive exotic plant monitoring protocol developed by the NCPN (in prep.), adapted from Andersen and Dewey (2007). The protocol emphasizes quick collection of IEP location and abundance data in order to maximize the amount of area searched, thus increasing our chances of finding a higher percentage of both new invasions and established IEPs. By focusing on roads, trails, and waterways, which are major vectors for invasive plants, we capture the greatest amount of information (i.e., benefit) with the least amount of time and effort (i.e., cost).

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

All roads, trails, and riparian areas were surveyed previously with monitoring routes and quadrats in both 2008 and 2010 (Perkins and Weissinger 2009; Perkins 2012).

2.1 Developing a park target invasive exotic plant list

Prior to beginning monitoring in 2012, NCPN and park staff reviewed the list of high-priority target IEPs (Table 2-1) that was initially developed in 2008 and then reviewed in 2010. The original list was developed by reviewing past park literature and state and county weed lists, and consulting with park staff and county weed managers. Our high-priority target IEP list includes existing IEPs and potential IEPs of high management concern. Because these methods were designed to be rapid, field crews were trained to develop a focused search image on the target plants, instead of looking for every possi-

ble invasive plant species. The likelihood of eradicating these target species, or containing them within a park, is generally high. The list of priority species is reviewed before each field season.

2.2 Monitoring routes

2.2.1 Minimum detection target size

The minimum detection target size (MDTS) represents the patch size that was large enough to detect with a high level of confidence (typically at least 90% of the total number of patches of that size and larger in the monitoring area) under actual field conditions, but small enough so that any missed patches smaller than the MDTS could still feasibly be eradicated if not found until the

Table 2-1. Priority invasive plant list, Golden Spike National Historic Site, 2008–2012.

Scientific name	Common name
<i>Cardaria chalepensis</i>	lens-podded whitetop
<i>Cardaria draba</i>	hoary cress
<i>Cardaria pubescens</i>	whitetop
<i>Carduus nutans</i>	musk thistle
<i>Centaurea diffusa</i>	diffuse knapweed
<i>Centaurea maculosa</i>	spotted knapweed
<i>Centaurea repens</i>	Russian knapweed
<i>Centaurea solstitialis</i>	yellow starthistle
<i>Centaurea squarrosa</i>	squarrose knapweed
<i>Cirsium arvense</i>	Canada thistle
<i>Condrilla juncea</i>	rush skeletonweed
<i>Convolvulus arvensis</i> *	field bindweed
<i>Crupina vulgaris</i>	common crupina
<i>Elymus repens</i>	quackgrass
<i>Euphorbia esula</i>	leafy spurge
<i>Hypericum perforatum</i>	common St. John's wort
<i>Isatis tinctoria</i>	Dyer's woad
<i>Lepidium latifolium</i>	perennial pepperweed
<i>Linaria dalmatica</i>	Dalmatian toadflax
<i>Marrubium vulgare</i>	horehound
<i>Onopordum acanthium</i>	Scotch thistle
<i>Salvia aethiopsis</i>	Mediterranean sage
<i>Senecio jacobaea</i>	tansy ragwort
<i>Taeniatherum caput-medusae</i>	Medusahead
<i>Tribulus terrestris</i>	puncturevine
<i>Verbascum blattaria</i>	moth mullein

*2008 only

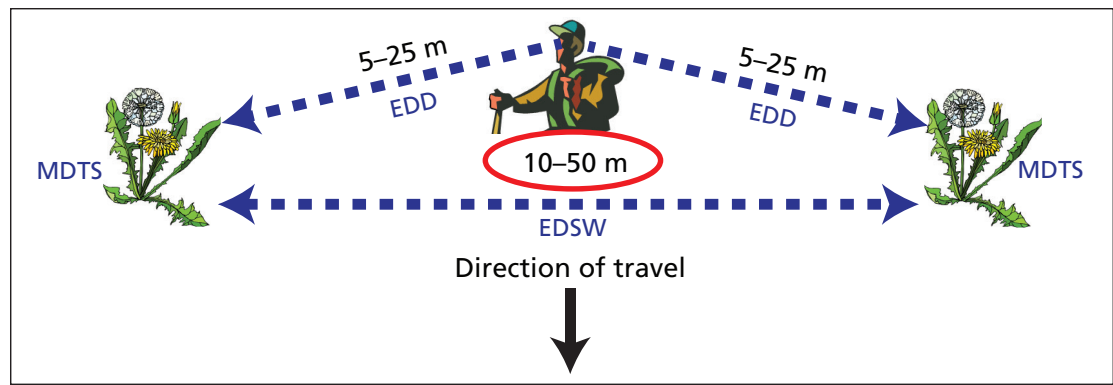


Figure 2-1. The maximum effective detection distance (EDD) at Golden Spike National Historic Site ranged from 5 to 25 meters, making the effective detection swath width (EDSW) 10–50 meters.

next scheduled monitoring visit. The NCPN has established an MDTs of 40 m² (0.01 acres, or approximately 20 × 20 ft) for all IEPs. Use of the MDTs is necessary because field technicians are not expected to find every single plant of every targeted weed species during route surveys. Although searching for single mature plants of some species, such as Russian olive (*Elaeagnus angustifolia*) and tamarisk (*Tamarix ramosissima*), is possible due to their large size, single plants of other species, such as field bindweed (*Convolvulus arvensis*), are nearly impossible to detect in most field conditions.

2.2.2 Effective detection distance

The effective detection distance (EDD) is the maximum distance from which a searcher could consistently detect (i.e., see and recognize) the MDTs of the least-visible targeted species with at least 90% detection efficiency (Figure 2-1). Crew members are trained by using fake plants of a targeted size and walking away and determining the maximum distance from which they could consistently see and recognize the patch with complete confidence. The size of the EDD is then estimated in the field by crew members. The distance is measured either by pacing or using a laser rangefinder. The EDD for GOSP was between 5 and 25 m in 2012, depending on vegetation.

2.2.3 Effective detection swath width

Effective detection swath width (EDSW) is defined as the maximum width of a linear search swath (band transect) in which a walking observer is confident of visually detecting 90% of all target species of the MDTs (Fig-

ure 2-1). The effective detection swath width (EDSW) is equal to two times the EDD, because the surveyor is able to effectively detect weeds for one EDD on either side of his/her search route. The EDSW ranged from 10 to 50 m at GOSP in 2012.

2.2.4 Patch separation resolution

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

2.2.5 Between feature position

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

2.2.6 Data collection methods

We walked one EDD out from one side of a monitoring route and then returned to the

starting point by walking back one EDD from the route on the other side. While walking, we searched for IEPs by visually scanning (side-to-side) all of the land within the borders of the swath. However, if the terrain was uneven or steep, and the observer had to glance frequently at the ground to ensure safe foot placement, then searchers stopped approximately every 10–50 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 designated as priority were consistently recorded during monitoring routes.

When a priority 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, then 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:

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:

1. Trace (<1%)
2. Low (1–5%)
3. Moderate (6–25%)

4. High (26–50%)
5. Majority (51–100%).

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

2.3 Monitoring transects

Our methods for sampling the monitoring quadrats were based on Stohlgren and others (2005). In 2010 and 2012, we established transects with three vegetation quadrats every 500 m along monitoring routes (Figure 2-2). If no invasives were detected for three consecutive transects (12 quadrats), then transects were established every 1,000 m. If invasive plants were found in categories greater than 1 for canopy cover class or infestation size class, then we went back to establishing transects every 500 m. (In 2008, methods differed slightly, as transects were placed every 400 m.)

2.3.1 Quadrat establishment

We centered vegetation quadrats at 0.5, 5, and 10 m away from the edge of a route on the same side as the route that was being walked and on alternating sides for riparian areas, small roads, or trails. A 1-m² sampling frame, placed on the right side of the transect line as the technician walked the monitoring route, was used to sample vegetation cover and soil surface features. In some cases, we leveled the sampling frame by propping up quadrat corners.

Quadrat-sampling methods used in 2010 and 2012 differed slightly from those used during the 2008 pilot field season. In 2008, all invasive species were recorded in monitoring quadrats and quadrats were embedded in a larger (177-m²) macroplot that was centered five meters from the monitoring route. In 2010, only priority species were recorded in the quadrats and along routes. In 2010 and 2012, observers could make additional species observations, but non-priority species were not thoroughly mapped.

2.3.2 Data collection methods

In the monitoring quadrats, all priority IEP species observed were recorded. In 2008 and 2010, cheatgrass (*Bromus tectorum*) and crested wheatgrass (*Agropyron cristatum*) were also recorded in the transects. However, due to a miscommunication, these two species were not recorded in 2012. For each quadrat, we recorded percent cover of each IEP using the following classes: <1, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11–25, 26–50, or >50%. We also recorded percent cover to the nearest 10% of dominant soil surface features (i.e., dead wood, dung, fungus, lichen, litter/duff, live root/bole, mineral soil/sediment, moss, biological soil crust, road, rock, standing water/flooded, stream, or trash/junk).

2.4 Analyses

We calculated the mean number of infestations per 100 m for monitoring routes. Percent cover estimates were generated from the monitoring quadrat data. We calculated the mean and standard error of percent cover by species for monitoring quadrats. For classes 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. Due to differences in observers' knowledge, only priority species should be used when comparing results from year to year.

3 Results

3.1 Park target IEP list

Twenty-five IEP species were identified as high-priority for Golden Spike NHS in 2012 (see Table 2-1). We recorded four IEP species (2 of which were priority) on monitoring routes and 0 in monitoring quadrats in 2012 (Table 3-1, Figure 3-1). We covered 111.0 hectares (274 acres) along monitoring routes in 2010, representing 11.8% of the entire park.

3.2 Monitoring routes

We walked a total of 19.5 km (12.1 miles) along 12 monitoring routes in 2012. We recorded a total of eight infestations, six of which were priority species (Table 3-2, Figure 3-1, Appendix A). Of the six priority infestations, two were larger than 40 m² (Table 3-3). Only priority species should be examined when comparing years and areas, as these were the only species recorded consistently by all observers and in both years.

3.3 Monitoring quadrats

We sampled a total of 34 transects in 2012 (Figure 3-2). No priority IEP species were

detected on any transect. No priority species were detected on transects in 2010 or 2008 (Perkins and Weissinger 2009; Perkins 2011).

3.4 Priority infestations over time

The number of priority infestations has declined dramatically—from 59 in 2008, to 46 in 2010, to just 6 in 2012 (Table 3-4). The species with the most dramatic declines from 2010 to 2012 were Dyer’s woad and Scotch thistle (*Onopordum acanthium*), which dropped from 25 infestations to 0, and 20 infestations to 2, respectively. These two species have also been the focus of control efforts by the Northern Rocky Mountain Exotic Plant Management Team (NPS 2012).

Four priority species that were detected in either 2008 or 2010 were not detected 2012: Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), Dyer’s woad (*Isatis tinctoria*), and horehound (*Marrubium vulgare*) (Table 3-4). No new priority species were detected in 2012.

Table 3-1. Invasive exotic plants detected at Golden Spike NHS, August 6–7, 2012.

Scientific name	Common name	Method detected		Priority?
		Routes	Transects	
<i>Onopordum acanthium</i>	Scotch thistle	X		Yes
<i>Verbascum blattaria</i>	moth mullein	X		Yes
<i>Convolvulus arvensis</i>	field bindweed	X		No
<i>Verbascum thapsus</i>	woolly mullein	X		No

Table 3-2. Number of priority IEP infestations by monitoring route, Golden Spike NHS, August 6–7, 2012.

Route	Route type	Length (m)	Area (ha)	Infestations		Infestations/ha	
				Total	Priority	Total	Priority
Hydro 1	Riparian	295	1.17	0	0	0.00	0.00
Last Cut Drainage	Riparian	1,874	14.52	1	0	0.07	0.00
	<i>All riparian</i>	<i>2,169</i>	<i>15.69</i>	<i>1</i>	<i>0</i>	<i>0.06</i>	<i>0.06</i>
Big Fill Section County Road	Road	5,152	25.70	3	2	0.12	0.08
County Road	Road	1,975	10.53	0	0	0.00	0.00
East Tour Road	Road	5,162	20.29	3	3	0.15	0.15
Facility Road	Road	676	6.05	0	0	0.00	0.00
Polsoms Road	Road	2,067	19.65	0	0	0.00	0.00
Residence Service Road	Road	164	1.14	0	0	0.00	0.00
Retired Service Road	Road	260	0.94	0	0	0.00	0.00
Water Tank Road	Road	447	3.77	0	0	0.00	0.00
Witkers Service Road	Road	464	2.20	0	0	0.00	0.00
	<i>All roads</i>	<i>16,367</i>	<i>90.27</i>	<i>6</i>	<i>5</i>	<i>0.06</i>	<i>0.06</i>
Pacific Track Grade	Trail	949	5.07	1	1	0.20	0.20
Total		19,485	111.04	8	6	0.07	0.05

Table 3-3. Number of infestations by species and infestation size class detected along monitoring routes at Golden Spike NHS, August 6–7, 2012.

Scientific name	Common name	Total infestations	Infestation size class*				
			1	2	3	4	5
<i>Verbascum blattaria</i>	moth mullein	4	0	2	2	0	0
<i>Onopordum acanthium</i>	Scotch thistle	2	1	1	0	0	0
<i>Convolvulus arvensis</i> **	field bindweed	1	1	0	0	0	0
<i>Verbascum thapsus</i> **	woolly mullein	1	0	1	0	0	0
Priority species		6	1	3	2	0	0
All species		8	2	4	2	0	0

*Infestation size classes: 1 = 1–a few plants ($\leq 2 \times 2$ 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).

**Not a priority species.

Table 3-4. Priority species observed and size of infestations detected at Golden Spike NHS on July 12–13, 2008, July 21–23, 2010, August 6–7, 2012.

Scientific name	Common name	Year	Total infestations	Infestation size class*				
				1	2	3	4	5
<i>Carduus nutans</i>	musk thistle	2008	2	1	1	0	0	0
		2010	0	0	0	0	0	
		2012	0	0	0	0	0	
<i>Cirsium arvense</i>	bull thistle	2008	1	0	0	1	0	0
		2010	0	0	0	0	0	
		2012	0	0	0	0	0	
<i>Isatis tinctoria</i>	Dyer's woad	2008	28	20	4	3	1	0
		2010	25	12	5	5	1	2
		2012	0	0	0	0	0	
<i>Marrubium vulgare</i>	horehound	2008	2	1	0	1	0	0
		2010	0	0	0	0	0	
		2012	0	0	0	0	0	
<i>Onopordum acanthium</i>	Scotch thistle	2008	26	8	8	10	0	0
		2010	20	7	6	6	1	0
		2012	2	1	1	0	0	
<i>Verbascum blattaria</i>	moth mullein	2008	0	0	0	0	0	
		2010	1	0	0	1	0	
		2012	4	0	2	2	0	
Priority species		2008	59	30	13	15	1	0
		2010	46	19	11	12	2	2
		2012	6	1	3	2	0	0

*Infestation size classes: 1 = 1–a few plants ($\leq 2 \times 2$ 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).

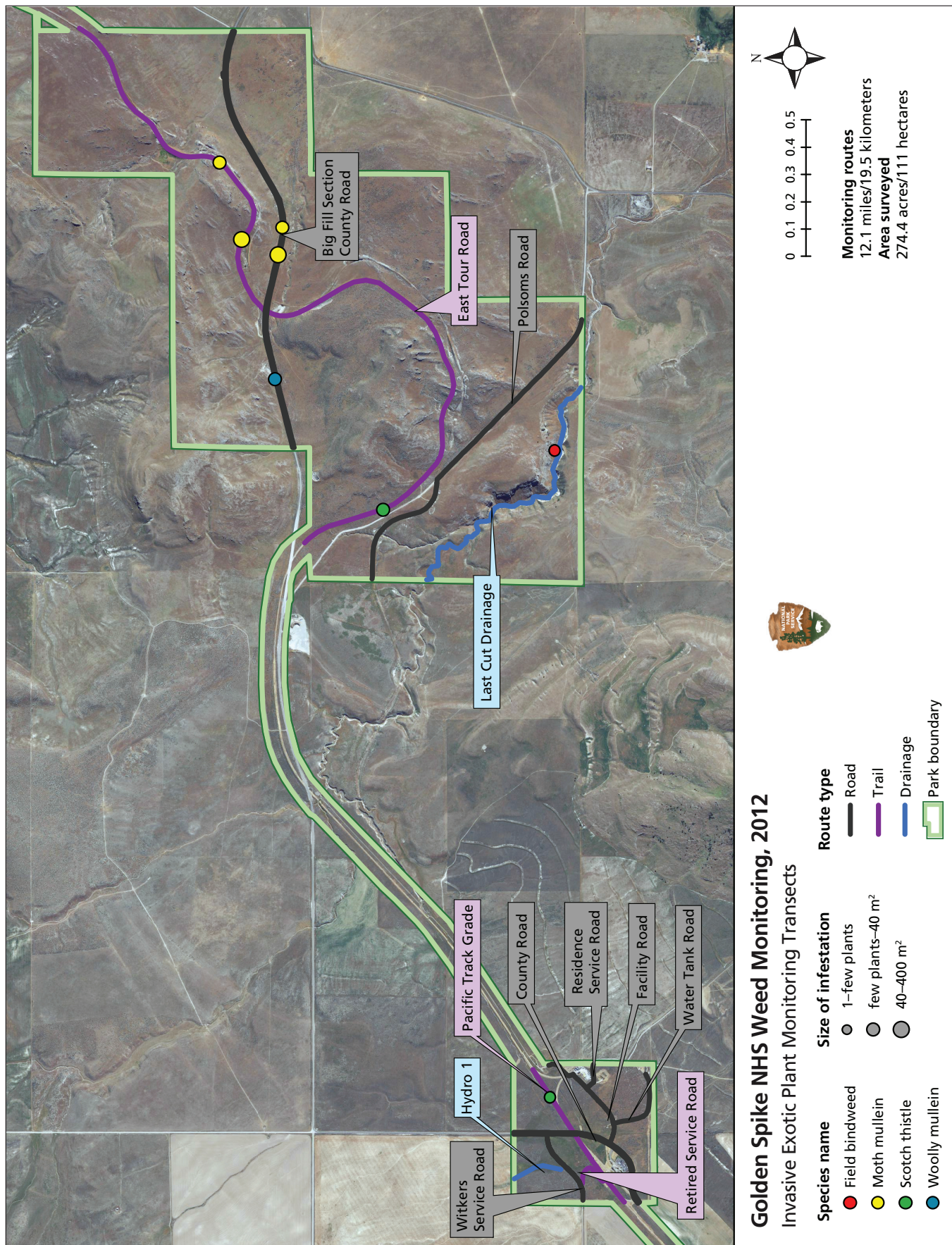


Figure 3-1. Invasive plant monitoring routes and invasive infestations detected along monitoring routes, Golden Spike National Historic Site, August 7-8, 2012.

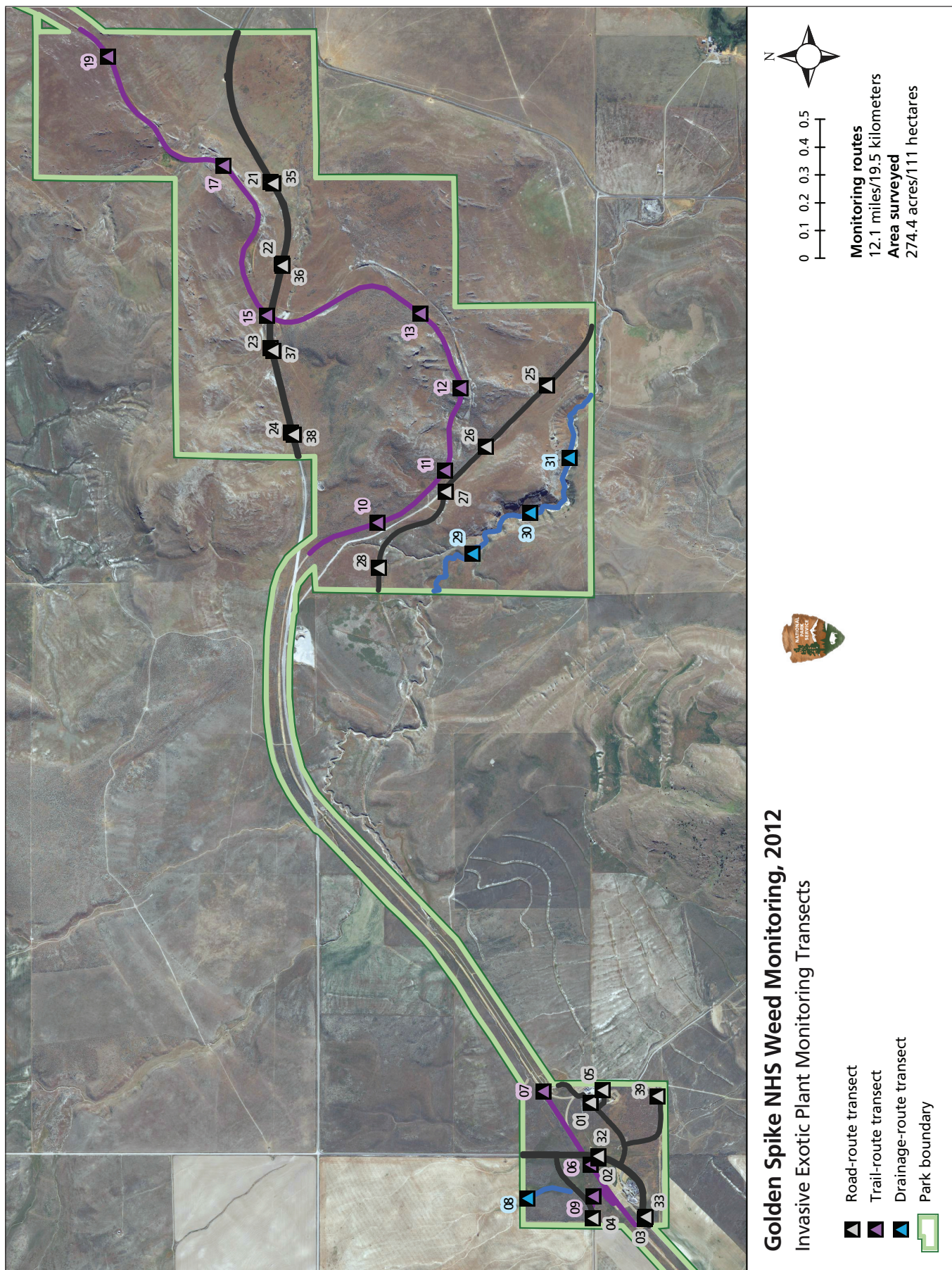


Figure 3-2. Invasive plant monitoring transects, Golden Spike National Historic Site, August 7–8, 2012.

4 Discussion

4.1 Priority IEP list

The NCPN will continue to work with Golden Spike NHS staff and area weed experts to review and update the list of priority species each year. Presence and absence data for most priority species should be reliable for the areas searched; however, absence data for other species are suspect, as they are not consistently recorded from year to year. Due to the low number of priority species detected, the park may want to consider adding species that are more widespread to the list of those considered for monitoring and control. In future years, the NCPN will collect data on cheatgrass and crested wheatgrass in transects only.

4.2 Possibilities for management control

Although priority IEPs have been dramatically reduced at Golden Spike NHS as control efforts have focused on these species (see Section 3.4), there still are several IEPs that are widespread but not on the priority list, including crested wheatgrass, cheatgrass, field bindweed, and redstem storksbill (*Erodium cicutarium*). It is recommended that the Northern Rockies Exotic Plant Management Team suggest additional species for possible control efforts upon review of this report. It should be noted that these crews have begun to focus on a gulch on adjacent private land that is a likely source of IEPs for the park (NPS 2012).

Estimates of percent cover in this report are limited to the routes surveyed; actual percent cover of IEPs across the entire park cannot be inferred with these methods. Because we have chosen to monitor along areas most likely to be invaded by a broad suite of IEPs, it is plausible that the percent cover for most IEP species is lower in the interior of the park than along the monitoring routes.

4.3 Future monitoring efforts

IEPs at Golden Spike NHS will generally be monitored at the same time of year every other year. Consistency in timing of monitoring should ensure consistency in detection probabilities and cover estimates of most species. For many species, sampling at any time from May to September is not expected to drastically alter the chances of detecting invasive species larger than the minimum detection target size. A complete fourth sample of monitoring routes will occur in 2014. Long-term trend reporting will focus on trends in species distributions, trends in percent cover of individual species, and changes in IEP percent cover of priority species by monitoring route. Extra-area surveys will also be considered for inventories at the park's request. The NCPN received peer review comments on the invasive plant monitoring protocol in September 2012. It is anticipated that the protocol will be finalized in 2013.

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

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