



Invasive Exotic Plant Monitoring at Golden Spike National Historic Site *2010 Field Season*

Natural Resource Technical Report NPS/NCPN/NRTR—2011/458



ON THE COVER

Golden Spike National Historic Site. NPS photo.

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Abstract

Invasive exotic plant (IEP) species are one of the biggest threats to natural ecosystem integrity and biodiversity, and controlling them is a high priority for the National Park Service. The Northern Colorado Plateau Network (NCPN) selected the early detection of IEPs as one of 10 monitoring protocols to be implemented as part of its long-term monitoring program. This report represents work completed during the 2010 field season at Golden Spike National Historic Site (GOSP). On July 21–23, 2010, twenty-five 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 transect. Four IEP taxa are widespread and may be beyond management control: crested wheatgrass (*Agropyron cristatum*), cheatgrass (*Bromus tectorum*), field bindweed (*Convolvulus arvensis*), and redstem storksbill (*Erodium cicutarium*). Several other species are present in small, localized invasions that have a greater chance of being successfully controlled through management actions. Infestation rates in 2010, as measured by infestations detected along monitoring routes and percent cover detected in monitoring transects, were very similar to rates estimated in 2008. The network will return to GOSP for a third year of monitoring in 2012.

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

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1 Introduction

Invasive exotic species fragment native ecosystems, displace native plants and animals, and alter ecosystem function. Invasive species are second only to habitat loss as threats to global biodiversity (Scott and Wilcove 1998) and represent one of the most serious threats to natural ecosystem integrity (National Research Council 2002). Biological invasions are occurring at accelerated rates in nearly every major ecosystem (Mooney and Hobbs 2000). Exotic plants negatively affect park resources and visitor enjoyment by altering landscapes and fire regimes, reducing native plant communities and animal habitat, and increasing trail-maintenance needs. Recognizing these challenges, national parks of the Northern Colorado Plateau Network (NCPN) identified invasive exotic plants (IEPs) as a high-priority vital sign for long-term monitoring (O'Dell et al. 2005).

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

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

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

Specific objectives of NCPN invasive exotic plant monitoring are:

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

This report summarizes the 2010 field season and second complete monitoring visit at Golden Spike National Historic Site (GOSP).

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 GOSP and NCPN staff reviewed and updated the list of target invasive plants for the park, 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 with monitoring routes and quadrats in both 2008 (Perkins and Weissinger 2009) and 2010.

2.1 Developing a park target invasive exotic plant list

Prior to beginning monitoring in 2010, NCPN and GOSP staff reviewed the list of high-priority target IEPs for GOSP (see Appendix A) that was initially developed in 2008. The original list was developed by reviewing past park literature and state and county weed lists, and consulting with park staff and county weed managers. Our high-priority target IEP list includes existing IEPs and potential IEPs of high management concern. Because these methods 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. The list of Priority 1 species is reviewed before every field season. Only one change was made from the 2008 Priority 1 list: we removed field bind-

weed (*Convolvulus arvensis*) from the list because it was too widespread to reasonably control.

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 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. 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 20 m in 2010, depending on vegetation.

2.2.3 Effective detection swath width

Effective detection swath width (EDSW) is defined as the maximum width of a linear search swath (band transect) in which a walking observer is confident of visually detecting 90% of all target species of the MDTS (Figure 2-1). The effective detection swath width (EDSW) is equal to two times the EDD, because the surveyor is able

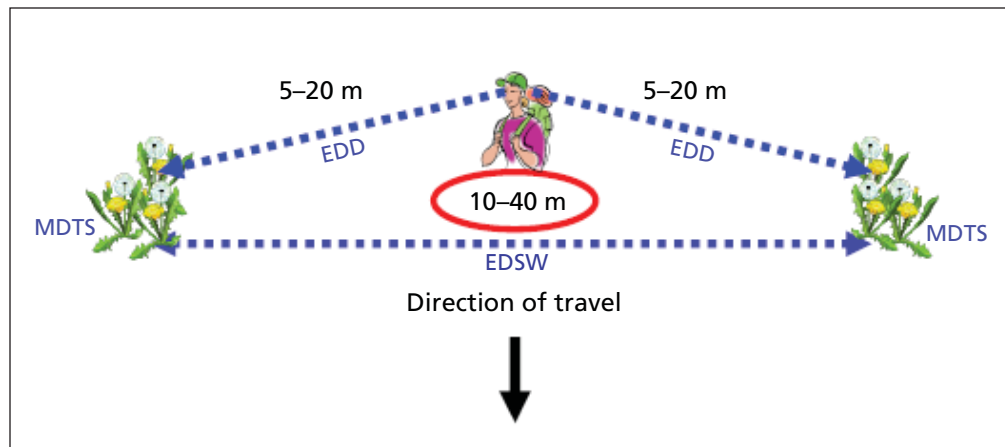


Figure 2-1. The maximum Effective Detection Distance (EDD) at Golden Spike NHS ranged from 5 to 20 meters, making the Effective Detection Swath Width (EDSW) 10–40 meters.

to effectively detect weeds for one EDD on either side of his/her search route. The EDSW ranged from 10 to 40 m at GOSP in 2010.

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

2.2.6 Data collection methods

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 10–40 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 designated as Priority 1 were consistently recorded during monitoring routes, with the exception of cheatgrass, which park staff requested we map along the Main Park Road. In 2010, survey crew members also decided to map matrimony vine (*Lycium barbarum*) and jointed goatgrass (*Aegilops cylindrica*); the latter had not been previously recorded for the park.

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:

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, 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 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 1 species were recorded in the quadrats and along routes. In 2010, observers could make additional species observations, but species other than Priority 1 were not thoroughly mapped.

2.3.2 Data collection methods

In the monitoring quadrats, all Priority 1 IEP species observed were recorded, as well as cheatgrass. 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 1 species should be used when comparing results from year to year.

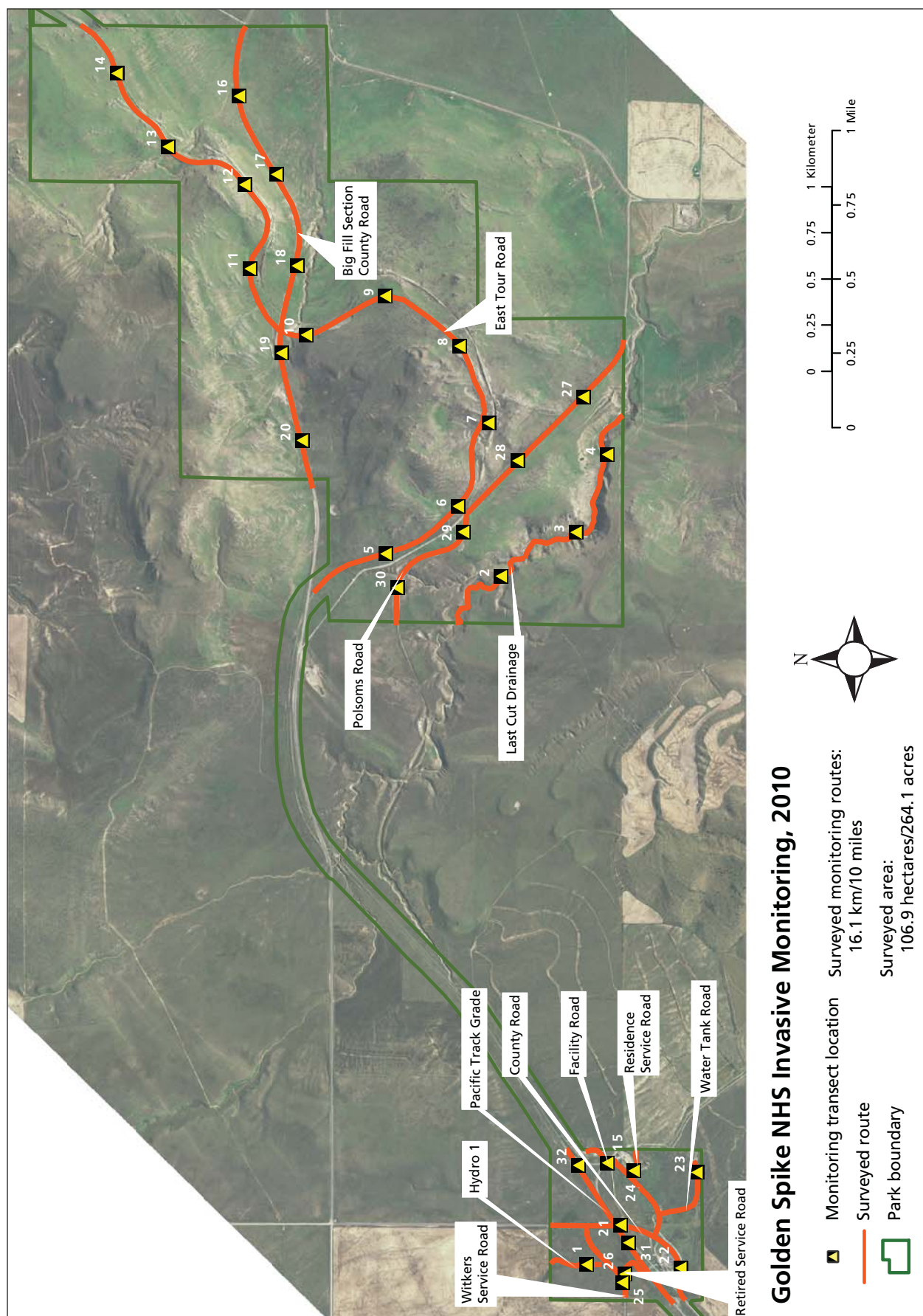


Figure 2-2. Monitoring transects at Golden Spike NHS, July 21–23, 2010.

3 Results

3.1 Park target IEP list

We identified twenty-five IEP species as Priority 1 for the GOSP target IEP list (Appendix A). This is one fewer than last year, because field bindweed (*Convolvus arvensis*) was removed from the list. We recorded five IEP species on monitoring routes and 16 in monitoring quadrats in 2010 (Table 3-1). Of the 21 IEP species detected, three were Priority 1 species. We covered 106.8 hectares (264 acres) along monitoring routes in 2010, representing 11.5% of the entire park.

3.2 Monitoring routes

We walked a total of 16.1 km (10.0 miles) along 12 monitoring routes in 2010. We recorded a total of 53 infestations, 46 of which were composed of Priority 1 species (Table 3-2, Figures 3-1, 3-2, Appendix B). Dyer's woad (*Isatis tinctoria*) and Scotch thistle (*Onopordum acanthium*) were the most commonly detected IEPs.* IEP numbers were much higher in the two riparian areas (Last Cut Drainage and Hydro 1) than on any other monitoring routes. Of the 53 infestations, 62% were classified as infestations of size classes 1 or 2. Sixty-five percent of Priority 1 infestations were classified in these two smallest size classes (Table 3-3).

Three Priority 1 species detected in 2008 were not detected 2010: Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*) and common horehound (*Marrubium vulgare*) (Table 3-4).** Moth mullein (*Verbascum blattaria*) was the only Priority 1 species newly detected in 2010.

3.3 Monitoring quadrats

We sampled a total of 32 transects in 2010 (see Figures 3-2, 3-3). IEP species were present on 100% of the transects, with an average of 2.38 IEPs per plot. No Priority 1 species were detected in the transects.

Cheatgrass (*Bromus tectorum*) was the most widespread IEP taxon, present in 90% of transects and with a mean canopy cover of 14.4% across all transects (Table 3.5). Cheatgrass was estimated to have 14.0% cover in 2008. Crested wheatgrass (*Agropyron cristatum*) and tumble mustard (*Sisymbrium altissimum*) were the next most prevalent species, present in 34% and 28% of the transects, respectively, with estimated cover of 6.2% and 0.1% cover parkwide. In 2008, crested wheatgrass and tumble mustard were estimated to have 6.35% and 1.39% cover, respectively. All other species were present in less than 20% of transects and had less than 0.3% cover over all transects.

*Only Priority 1 species should be examined when comparing years and areas, as these were the only species recorded consistently by all observers and in both years.

**Field bindweed (*Convolvulus arvensis*), was on the Priority 1 list in 2008 but was removed from the list in 2010, and is almost certainly still present.

Table 3-1. Invasive exotic plants detected at Golden Spike NHS, July 21–23, 2010.

Scientific name	Common name	Method detected		Park priority
		Routes	Quadrats	
<i>Isatis tinctoria</i>	Dyer's woad	X		1
<i>Onopordum acanthium</i>	Scotch thistle	X		1
<i>Verbascum blattaria</i>	moth mullein	X		1
<i>Aegilops cylindrica</i>	jointed goatgrass	X		Not on list
<i>Agropyron cristatum</i>	crested wheatgrass		X	Not on list
<i>Alyssum desertorum</i>	desert madwort		X	Not on list
<i>Bromus briziformis</i>	rattlesnake chess		X	Not on list
<i>Bromus japonicus</i>	Japanese chess		X	Not on list
<i>Bromus tectorum</i>	cheatgrass		X	Not on list
<i>Camelina microcarpa</i>	little-pod false flax		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 pepperwort		X	Not on list
<i>Lycium barbarum</i>	matrimony vine	X		Not on list
<i>Melilotus officinalis</i>	yellow sweetclover		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>Salsola tragus</i>	Russian thistle		X	Not on list
<i>Sisymbrium altissum</i>	tumble mustard		X	Not on list
<i>Tragopogon dubius</i>	yellow salsify		X	Not on list
<i>Veronica biloba</i>	two-lobed speedwell		X	Not on list

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

Table 3-2. IEP infestations per route surveyed, Golden Spike NHS, July 21–23, 2010.

Route	Type	Length (m)	Area (ha)	Infestations	
				Number (Priority 1)	Number/ha (Priority 1)
Hydro 1	Riparian	289	0.91	5 (5)	5.52 (5.52)
Last Cut Drainage	Riparian	1,830	11.60	28 (25)	2.41 (2.15)
	<i>All Riparian</i>	<i>2,119</i>	<i>12.51</i>	<i>33 (30)</i>	<i>3.97 (3.84)</i>
Big Fill Section County Road	Road	2,625	15.47	1 (0)	1.25 (0.00)
County Road	Road	985	7.22	9 (6)	1.25 (0.83)
East Tour Road	Road	5,216	40.97	2 (2)	0.05 (0.05)
Facility Road	Road	698	4.45	2 (2)	0.45 (0.45)
Polsoms Road	Road	2,086	13.08	4 (4)	0.31 (0.31)
Residence Service Road	Road	164	0.54	0 (0)	0.00 (0.00)
Retired Service Road	Road	260	0.31	0 (0)	0.00 (0.00)
Water Tank Road	Road	448	2.30	0 (0)	0.00 (0.00)
Witkers Service Road	Road	464	1.31	1 (1)	0.77 (0.77)
	<i>All Roads</i>	<i>12,946</i>	<i>85.63</i>	<i>19 (16)</i>	<i>0.32 (0.27)</i>
Pacific Track Grade	Trail	1,026	8.72	1 (0)	0.11 (0.00)
Total		16,091	106.86	53 (46)	0.91 (0.85)

Table 3-3. Species observed and size of infestation detected along monitoring routes at Golden Spike NHS, July 21–23, 2010.

Scientific name	Common name	Total infestations	Infestation size class Number of infestations				
			1	2	3	4	5
<i>Aegilops cylindrica</i>	jointed goatgrass	3	2	1	0	0	0
<i>Isatis tinctoria</i>	Dyer's woad	25	12	5	5	1	2
<i>Lycium barbarum</i>	matrimony vine	4	0	0	2	1	1
<i>Onopordum acanthium</i>	Scotch thistle	20	7	6	6	1	0
<i>Verbascum blattaria</i>	moth mullein	1	0	0	1	0	0
Priority 1 species		46	19	11	12	2	2
All species		53	21	12	14	3	3

Priority 1 species are bolded.

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

Golden Spike NHS Invasive Monitoring, 2010 Big Fill Area

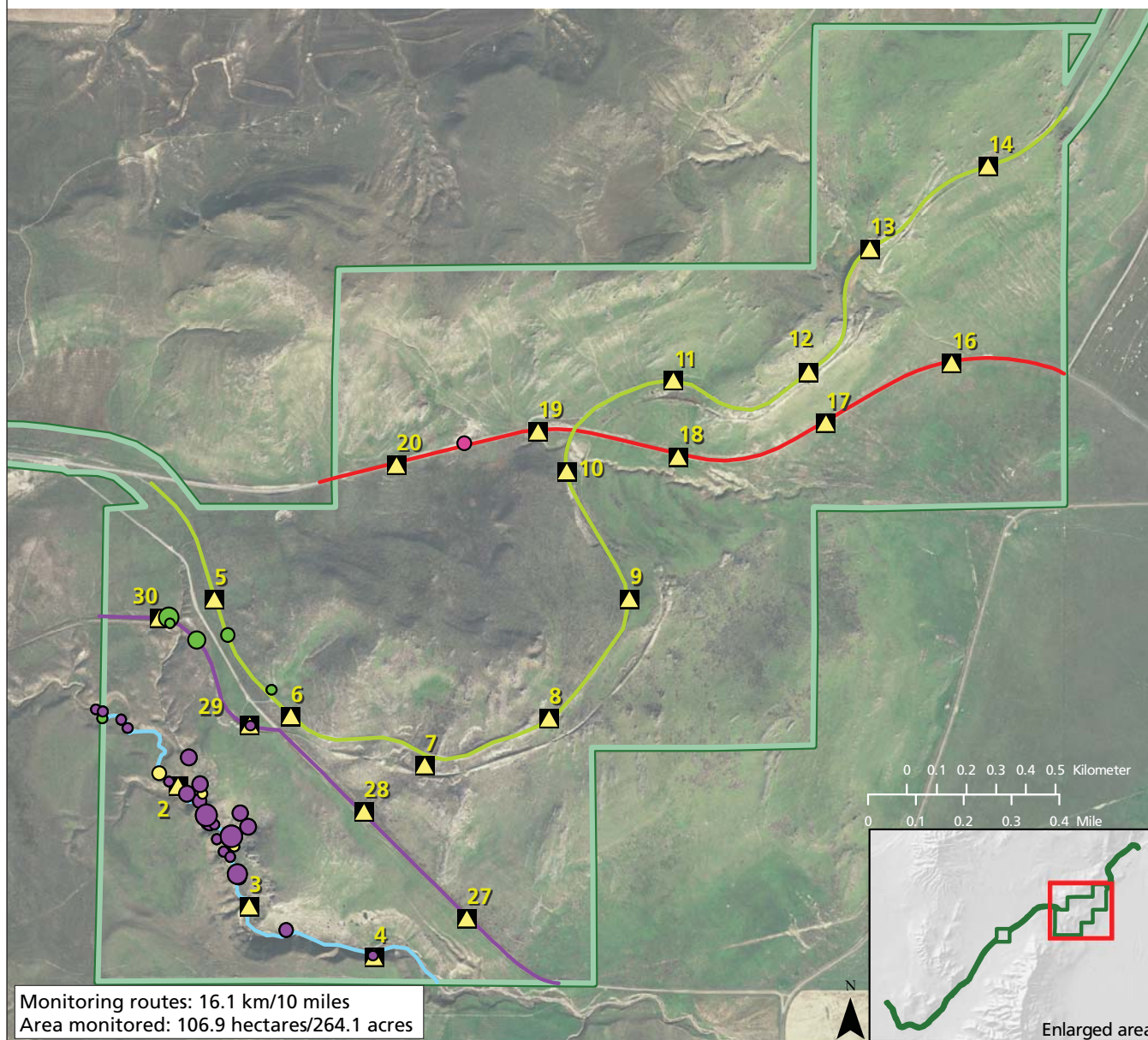
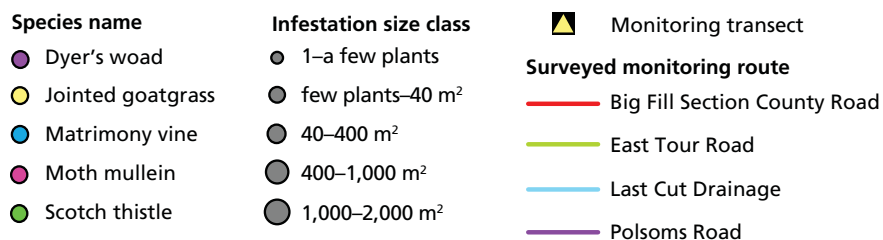


Figure 3-2. Invasive plant monitoring routes, monitoring plots, and invasives detected along monitoring routes, Big Fill area, Golden Spike NHS, July 21–23, 2010.

Golden Spike NHS Invasive Monitoring, 2010 Administrative Area

Species name	Infestation size class	Monitoring transect
● Dyer's woad	● 1–a few plants	▲ Monitoring transect
● Jointed goatgrass	● few plants–40 m ²	— Surveied monitoring route
● Matrimony vine	● 40–400 m ²	— Big Fill Section County Road
● Moth mullein	● 400–1,000 m ²	— East Tour Road
● Scotch thistle	● 1,000–2,000 m ²	— Last Cut Drainage
		— Polsoms Road

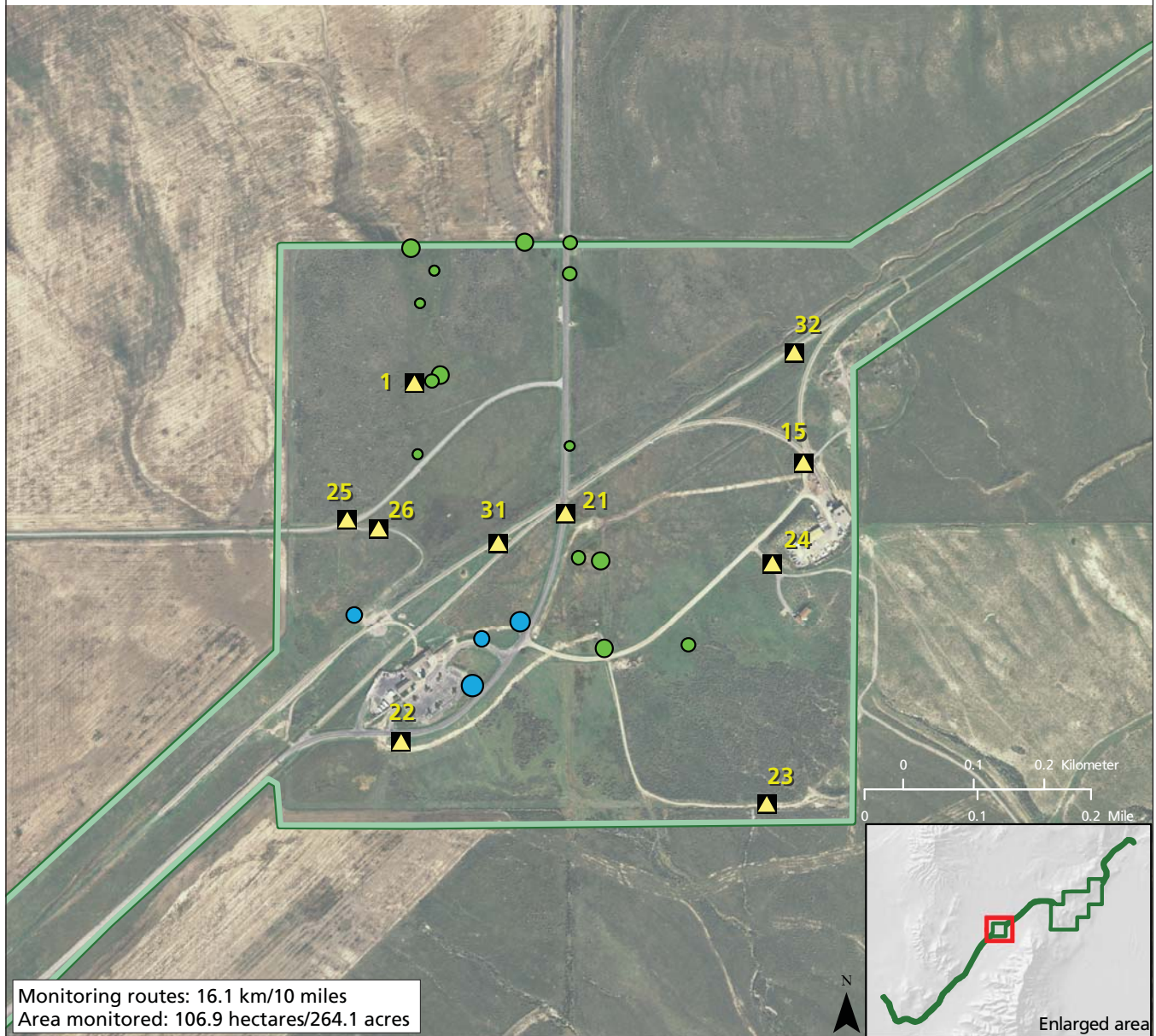


Figure 3-3. Invasive plant monitoring routes, monitoring plots, and invasives detected along monitoring routes, Last Spike administrative area, Golden Spike NHS, July 21–23, 2010.

Table 3-4. Priority 1 species observed and size of infestations detected on monitoring routes at Golden Spike NHS on July 12–13, 2008 and July 21–23, 2010.

Scientific name	Common name	Year	Total infestations	Infestation size class Number of infestations				
				1	2	3	4	5
<i>Carduus nutans</i>	musk thistle	2008	2	1	1	0	0	0
		2010	0	0	0	0	0	
<i>Cirsium arvense</i>	Canada thistle	2008	1	0	0	1	0	0
		2010	0	0	0	0	0	
<i>Convolvulus arvensis</i> *	field bindweed	2008	41	5	15	14	5	2
		2010	-	-	-	-	-	
<i>Isatis tinctoria</i>	Dyer's woad	2008	28	20	4	3	1	0
		2010	25	12	5	5	1	2
<i>Marrubium vulgare</i>	white horehound	2008	2	1	0	1	0	0
		2010	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
<i>Verbascum blattaria</i>	moth mullein	2008	0	0	0	0	0	
		2010	1	0	0	1	0	
Priority 1 species		2008	59	30	13	15	1	0
		2010	46	19	11	12	2	2

*removed from Priority 1 list prior to 2010 field season.

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

Table 3-5. Number of monitoring transects where exotic plant species were detected, mean percent cover, and standard error by sampling area (management unit or monitoring route), Golden Spike NHS, July 21–23, 2010.

Species	Common name	Sampling area	# of transects detected	Percent cover (SE)
<i>Agropyron cristatum</i>	crested wheatgrass	LS Area (10)	8	16.8 (5.3)
		Last Cut (3)	2	0.8 (0.6)
		PORO (4)	1	11.9 (6.4)
		GOSP (32)	11	6.2 (2.3)
<i>Alyssum desertorum</i>	desert madwort	Last Cut (3)	1	0.1 (0.1)
		PORO (4)	2	0.3 (0.2)
		GOSP (32)	3	<0.1 (<0.1)
<i>Bromus briziformis</i>	rattlesnake chess	Last Cut (3)	2	0.2 (0.1)
		GOSP (32)	2	0.2 (0.1)
<i>Bromus japonicus</i>	Japanese chess	LS Area (10)	1	0.4 (0.4)
		PORO (4)	2	0.4 (0.3)
		GOSP (32)	3	0.2 (0.1)
<i>Bromus tectorum</i>	cheatgrass	LS Area (10)	8	8.8 (2.8)
		Last Cut (3)	2	11.5 (5.8)
		ETR (5)	10	25.9 (6.2)
		BFSC (10)	5	10.0 (3.8)
		PORO (4)	4	11.9 (6.4)
		GOSP (32)	29	14.4 (2.7)
<i>Camelina microcarpa</i>	little-pod false flax	Last Cut (3)	2	0.2 (0.1)
		PORO (4)	1	0.04 (0.04)
		GOSP (32)	3	<0.1 (<0.1)
<i>Erodium cicutarium</i>	redstem storksbill	LS Area (10)	1	0.1 (0.2)
		PORO (4)	1	0.1 (0.1)
		GOSP (32)	2	<0.1 (<0.1)
<i>Lactuca serriola</i>	prickly lettuce	LS Area (10)	3	0.2 (0.1)
		PORO (4)	1	0.2 (0.2)
		GOSP (32)	4	0.1 (0.03)
<i>Lepidium perfoliatum</i>	clasping pepperwort	LS Area (10)	1	0.02 (0.02)
		GOSP (32)	1	<0.1 (<0.1)
<i>Melilotus officinalis</i>	yellow sweetclover	LS Area (10)	3	0.4 (0.2)
		Last Cut (3)	2	0.6 (0.5)
		GOSP (32)	5	0.2 (0.1)
<i>Poa pratensis</i>	Kentucky bluegrass	Last Cut (3)	1	0.1 (0.1)
		PORO (4)	3	0.4 (0.1)
		GOSP (32)	4	<0.1 (<0.1)
<i>Polygonum aviculare</i>	prostrate knotweed	LS Area (10)	1	0.03 (0.03)
		GOSP (32)	1	<0.1 (<0.1)
<i>Salsola tragus</i>	Russian thistle	Last Cut (3)	1	0.3 (0.3)
		GOSP (32)	1	<0.1 (<0.1)

Table 3-5. Number of monitoring transects where exotic plant species were detected, mean percent cover, and standard error by sampling area (management unit or monitoring route), Golden Spike NHS, July 21–23, 2010, cont.

Species	Common name	Sampling area	# of transects detected	Percent cover (SE)
<i>Sisymbrium altissimum</i>	tumble mustard	LS Area (10)	3	0.3 (0.2)
		Last Cut (3)	1	0.1 (0.1)
		ETR (5)	3	0.2 (0.4)
		BFSC (10)	1	0.1 (0.3)
		PORO (4)	1	0.1 (0.1)
		GOSP (32)	9	0.1 (0.1)
<i>Tragopogon dubius</i>	yellow salsify	PORO (4)	1	0.1 (0.1)
		GOSP (32)	1	0.2 (0.1)
<i>Veronica biloba</i>	two-lobed speedwell	Last Cut (3)	1	0.2 (0.2)
		GOSP (32)	1	<0.1 (<0.1)

Total number of transects per route are listed in parentheses.

LS = Last Spike Administrative Area; ETR = East Tour Road; BFSC = Big Fill Section County Road; PORO = Polsoms Road

4 Discussion

4.1 Priority 1 IEP List

The NCPN will continue to work with GOSP staff and area weed experts to review and update the list of priority species each year. Presence and absence data for most Priority 1 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. We currently have no recommendations for subtractions from the GOSP Priority 1 invasive plant list.

4.2 Possibilities for management control

Exotic plants are widespread at GOSP, with at least one IEP detected in 100% of monitoring plots. Four taxa are widespread and may be beyond management control: crested wheatgrass, brome, field bindweed, and redstem storksbill. GOSP has a high percent cover (14.4%) of cheatgrass across all transects.

However, 65% of Priority 1 infestations 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 Scotch thistle and moth mullein.

In 2008, small patches of white horehound (*Marubium vulgare*) were detected along the East Tour Road, north of the Big Fill section of County Road. These infestations were recommended for control, and this species was not found in 2010. Two infestations of musk thistle and one of Canada thistle were also found in 2008, but not detected in 2010. Dyer's woad continues to have high infestation rates in riparian areas, but because only one individual plant of this species was recorded outside of riparian areas, 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.

In 2010, invasives appeared to be at levels similar to those of 2008. Detections of Priority 1 invasives along monitoring routes in 2008 and 2010 were similar. We reduced our quadrat sampling by about 18% in 2010 (39 and 32 transects in

2008 and 2010, respectively) in an effort to make the protocol more efficient. New transects are selected for monitoring each year, because previous detections of invasives may have been targeted for eradication. Despite the reduction in sampling effort and non-permanent plots, estimates of percent cover were similar from 2008 to 2010 (14.0% to 14.4% for cheatgrass, 6.35% to 6.20% for crested wheatgrass, 1.39% and 0.10% for tumble mustard).

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.

4.3 Future monitoring efforts

IEPs at GOSP 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 third sample of monitoring routes will occur in 2012. Long-term trend reporting will focus on trends in species distributions, trends in percent cover of individual species, and changes in IEP percent cover of Priority 1 species by monitoring route. Extra-area surveys will also be considered for inventories at the park's request. The NCPN invasive plant monitoring protocol was submitted for peer review in December 2010.

4.4 New species

During this field season, the NCPN recorded one new species, little-pod false flax (*Camelina microcarpa*), for GOSP. This non-native species can be invasive. It is native to Africa, Europe, and temperate Asia.

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Appendix A. Golden Spike National Historic Site Priority 1 Invasive Exotic Plant List

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 skeltonweed
<i>Crupina vulgaris</i>	common crupina
<i>Elymus repens</i>	quackgrass
<i>Euphorbia esula</i>	leafy spurge
<i>Hypericum perforatum</i>	common St. Johnswort
<i>Isatis tinctoria</i>	Dyer's woad
<i>Lepidium latifolium</i>	perennial pepperweed
<i>Linaria dalmatica</i>	Dalmatian toadflax
<i>Marrubium vulgare</i>	white 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 rye
<i>Tribulus terrestris</i>	puncture vine
<i>Verbascum blattaria</i>	moth mullein

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Golden Spike NHS, July 21–23, 2010

Monitoring route	Scientific name	Common name	Infestation size class	Cover class	Pulled?	Northing	Easting
Big Fill Section County Road County Road	<i>Verbascum blattaria</i>	moth mullein	3	2	No	4610480	375486.1
	<i>Lycium barbarum</i>	matrimony-vine	5	2	No	4608435	370871.5
			3	4	No	4608501	370885.3
			4	3	No	4608526	370939.7
	<i>Onopordum acanthium</i>	Scotch thistle	1	2	No	4608775	371010
			3	3	No	4608612	371054.3
			3	3	No	4609065	370946.6
			2	2	No	4609020	371010
			2	3	No	4608616	371022.8
			2	3	No	4609064	371010.9
East Tour Road	<i>Onopordum acanthium</i>	Scotch thistle	1	3	No	4609650	374836.8
			2	3	No	4609835	374690.8
Facility Road	<i>Onopordum acanthium</i>	Scotch thistle	3	3	No	4608488	371059.3
			2	3	No	4608493	371178.5
Hydro 1	<i>Onopordum acanthium</i>	Scotch thistle	1	3	No	4609025	370817.8
			1	3	Yes	4608978	370797.3
			3	2	No	4609056	370784.2
			3	3	No	4608876	370826.3
			2	2	No	4608868	370814.3
Last Cut Drainage	<i>Isatis tinctoria</i>	Dyer's woad	5	2	No	4609228	374618.1
			5	2	No	4609158	374702.7
			1	5	No	4609106	374676.6
			1	5	No	4608754	375178.2
			1	5	No	4609585	374246.1
			1	5	No	4609578	374270
			1	5	No	4609237	374606.8
			1	5	No	4609196	374645.7
			1	5	No	4609521	374352.8

Appendix B. Exotic Plant Invasions Detected on Monitoring Routes at Golden Spike NHS, July 21–23, 2010, cont.

Monitoring route	Scientific name	Common name	Infestation size class	Cover class	Pulled?	Northing	Easting
Last Cut Drainage	<i>Isatis tinctoria</i>	Dyer's woad	1	5	No	4609550	374332.4
			1	5	No	4609148	374653.6
			1	5	No	4609088	374698.8
			1	5	No	4609340	374493.3
			3	3	No	4609424	374559.5
			3	3	No	4609190	374759.1
			3	3	No	4609301	374552.1
			3	3	No	4609235	374732.2
			3	3	No	4609333	374598.1
			4	3	No	4609030	374722.5
			2	4	No	4609019	374728.2
			2	5	No	4609277	374596.4
			2	5	No	4609200	374629.8
			2	5	No	4609204	374623
			2	5	No	4608842	374887.1
Pacific Track Grade	<i>Aegilops cylindrica</i>	jointed goatgrass	1	5	No	4609301	374605.8
			1	5	No	4609122	374711.5
			2	5	No	4609370	374459.7
	<i>Onopordum acanthium</i>	Scotch thistle	1	5	No	4609553	374268
	<i>Lycium barbarum</i>	matrimony-vine	3	3	No	4608535	370703.6
	<i>Isatis tinctoria</i>	Dyer's woad	1	5	No	4609529	374766
			1	5	No	4609874	374496.9
			3	2	No	4609817	374586.7
	<i>Onopordum acanthium</i>	Scotch thistle	4	2	No	4609894	374491.8
			1	2	No	4608764	370794.1
Witkers Service Road	<i>Onopordum acanthium</i>	Scotch thistle	1	2	No	4608764	370794.1

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