



Invasive Exotic Plant Monitoring at Golden Spike National Historical Park

2024 Field Season



Cheatgrass grows along the tracks near a historic steam locomotive at Golden Spike.

NPS / LUKE GOMMERMANN

Invasive Exotic Plant Monitoring at Golden Spike National Historical Park: 2024 Field Season

Science Report NPS/SR—2025/352

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Please cite this publication as:

Perkins, D.W. 2025. Invasive Exotic Plant Monitoring at Golden Spike National Historical Park: 2024 Field Season. Science Report NPS/SR—2025/352. National Park Service, Fort Collins, Colorado. <https://doi.org/10.36967/2315453>

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Abstract

Invasive exotic plant (IEP) species are among the biggest threats to natural ecosystem integrity and biodiversity, and their control is a high priority for the National Park Service. The Northern Colorado Plateau Network (NCPN) selected early detection of IEPs as one of the 11 monitoring protocols implemented as part of its long-term monitoring program. This report summarizes work completed during the 2024 field season at Golden Spike National Historical Park (NHP). On June 20–21, 2024, we recorded six priority IEP species during monitoring at the park. Sixty priority IEP patches were detected along 20.3 km (12.6 miles) of 13 monitoring routes that covered all major roads, trails, and riparian areas. Three additional widespread IEP species were recorded only in transects. The highest densities of IEP patches were recorded along the Last Cut drainage, followed by the Facility Road, Residence Service Road, East Tour Road, and Retired Service Road. Field bindweed (*Convolvulus arvensis*) and Scotch thistle (*Onopordum acanthium*) were the most prevalent priority species, representing 88% of all recorded patches. Compared to 2021, there was a decrease in the number of IEP patches per kilometer in 2024, driven by a decrease of rush skeletonweed (*Chondrilla juncea*). More-widespread species monitored in transects were still common, with cheatgrass (*Bromus tectorum*), crested wheatgrass (*Agropyron cristatum*), and tumble mustard (*Sisymbrium altissimum*) present in 82%, 36%, and 21% of all transects, respectively. At least one of these species in all of the 39 transects monitored.

Acknowledgments

A. Washuta and A. Kelly conducted field work. A. Wight was extremely helpful in generating routes, quadrats, and other GIS information. R. Carroll assisted with arranging site logistics and sharing data on control efforts. J. Brehm improved this report with their thoughtful review. Data management was provided by H. Thomas, T. Nash and J. Brehm. M. Schrade 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 among the top threats to biodiversity (Maxwell et al. 2016) 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, the 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 1999). NCPN IEP monitoring aims to facilitate strategic control by detecting and identifying existing invasions and, where possible, track changes in the abundance and distribution of priority IEPs in parks along key invasive pathways.

Invasive exotic plants can spread into national parks via multiple types of pathway. Predictable IEP pathways include roads, trails, and riparian corridors. Long-distance dispersal through cargo containers and air freight is an example of sudden pathways. Anthropogenic pathways include horticultural escapes and seeds transported on shoes and in restoration seed mixes. For the National Park Service, the consequences of these plant invasions present a significant challenge to maintain natural resources “unimpaired for the enjoyment of future generations” (NPS 1916).

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. Due to this challenge, the NCPN focuses 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, animals, or both.

Specific objectives of NCPN invasive exotic plant monitoring are:

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

This report summarizes IEP monitoring results from the 2024 field season and the start of the third monitoring rotation at Golden Spike National Historical Park (NHP).

2 Methods

We followed the invasive plant monitoring protocol developed by the NCPN (Perkins et al. 2016). The protocol emphasizes the rapid collection of IEP location and abundance data to maximize the 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 priority invasive plants (see Section 2.1), 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 quantitatively, are used to make inference about 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. This process maximizes our opportunities for detecting IEPs in the park. All roads, trails, and riparian areas surveyed in 2024 were previously surveyed with monitoring routes and quadrats in 2008, 2010, 2012, 2014, 2016, 2018, and 2021 (Perkins 2011, 2013, 2015, 2017, 2022; Perkins and Weissinger 2009; Washuta and Perkins 2019).

2.1 Developing a Park Priority Invasive Exotic Plant List

Prior to beginning monitoring in 2024, staff from the NCPN and Golden Spike NHP reviewed the park's list of priority IEPs (Table 1). The original list of target IEPs was developed by reviewing past park literature and state and county weed lists, as well as consulting with park staff and county weed managers. No species were added in 2023. The priority IEP list includes existing IEPs and potential IEPs of high management concern. These methods were designed to be rapid by training field crews to develop a focused search image on the priority IEPs, rather than looking for every possible invasive plant species. Eradicating these priority species, or containing them within a park, is still thought to be possible. Species on the priority list generally have the potential to be managed or even eradicated within the park. We also record crested wheatgrass (*Agropyron cristatum*), cheatgrass (*Bromus tectorum*), and tumble mustard (*Sisymbrium altissimum*) in all transects.

Table 1. Priority invasive plant list, Golden Spike NHP, 2008–2024.

Scientific Name	Common Name
<i>Cardaria</i> sp.	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

^A Not on list in 2010–12.

Table 1 (continued). Priority invasive plant list, Golden Spike NHP, 2008–2024.

Scientific Name	Common Name
<i>Centaurea virgata</i>	squarrose knapweed
<i>Chondrilla juncea</i>	rush skeletonweed
<i>Cirsium arvense</i>	Canada thistle
<i>Convolvulus arvensis</i> ^A	field bindweed
<i>Crupina vulgaris</i>	common crupina
<i>Elymus repens</i>	quackgrass
<i>Euphorbia esula</i>	leafy spurge
<i>Hypericum perforatum</i>	St. John's wort
<i>Isatis tinctoria</i>	dyer's woad
<i>Lepidium latifolium</i>	broad-leaf pepperwort
<i>Linaria dalmatica</i>	Dalmatian toadflax
<i>Marrubium vulgare</i>	horehound
<i>Onopordum acanthium</i>	Scotch thistle
<i>Salvia aethiopis</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

^A Not on list in 2010–12.

2.2 Monitoring Routes

While observers strive to observe and map all priority IEP patches along monitoring routes, some priority IEP species, especially those with low numbers and small size, will inevitably be overlooked. To account for these non-detections, the NCPN has developed a minimum detection target size (MDTS), effective detection distance (EDD), and effective detection swath width (EDSW) that are based on the observability of the least-visible priority IEP species. Therefore, these areas and distances should be considered conservative estimates of an observer's ability to detect IEP patches, as most (and potentially, all) IEP patches mapped during monitoring are made up of more easily visible species. As a result, many mapped patches of priority IEP species are observed partially or completely beyond these values.

2.2.1 Minimum Detection Target Size

The minimum detection target size (MDTS) represents the patch size 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 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 priority IEPs. Use of the MDTS is necessary because field technicians are not expected to find every single plant of every priority IEP species during route surveys. Although searching for

single mature plants of some priority IEP species, such as tamarisk (*Tamarix* sp.), is possible due to their large size, single plants of other priority IEP species, such as field bindweed (*Convolvulus arvensis*), are nearly impossible to detect in most field conditions unless the observer is near the patch.

2.2.2 Effective Detection Distance

The effective detection distance (EDD) is the maximum distance from which a searcher can consistently detect (i.e., see and recognize) the MDTS of the least-visible priority IEP species with at least 90% detection efficiency (Figure 1). Crew members are trained to quantify EDD by walking away from the least-visible priority IEP species (or, if this species is not present, plants of similar stature) from an MDTS (i.e., 40 m²) and determining the maximum distance from which they could consistently see and recognize this patch with complete confidence.

The size of the EDD is quantified in the field by crew members at the start of each monitoring route and adjusted as necessary, depending on surrounding vegetation and terrain. In 2024, the EDD for Golden Spike NHP was between 5 and 8 m.

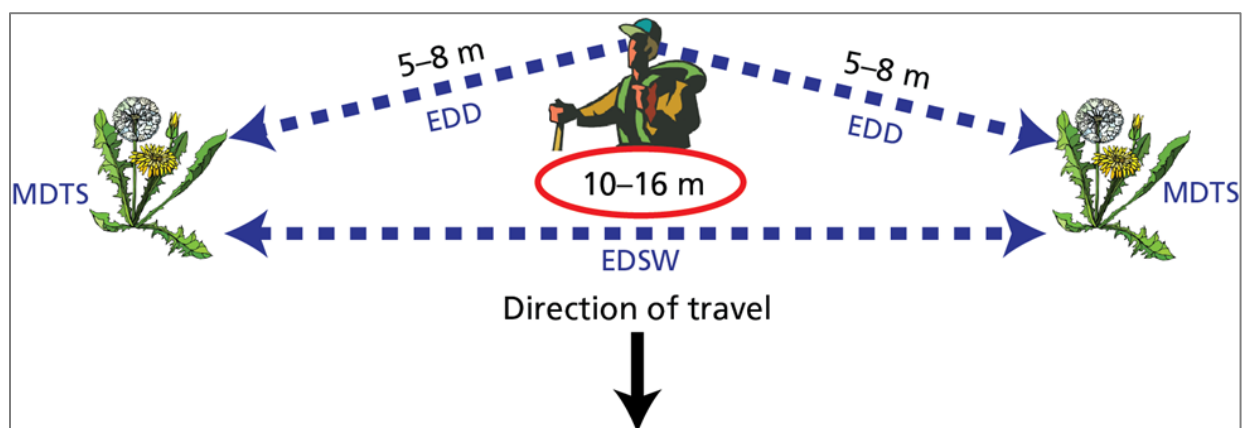


Figure 1. The maximum Effective Detection Distance (EDD) at Golden Spike NHP ranged from 5–8 meters in 2024, making the Effective Detection Swath Width (EDSW) 10–16 meters.

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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 priority species meeting the MDTS (Figure 1). The effective detection swath width (EDSW) is equal to two times the EDD, because the surveyor can effectively detect priority IEPs for one EDD on either side of the search route. The EDSW ranged from 10 to 16 m at Golden Spike NHP in 2024.

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 infestations or patches. Individuals or clusters of a priority 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. 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 patch during planning and implementation of weed control operations. If a patch is continuous for more than 50 m, then cover estimates are made every 50 m to aid in developing an effective management strategy for the entire patch.

2.2.5 Data Collection Methods

Observers walked down the center of the route (see Figure 2), searching for priority IEPs by visually scanning side-to-side all the land within the EDSW. If the terrain was uneven or steep, and the observers had to glance frequently at the ground to ensure safe foot placement, then searchers stopped approximately every 10–16 m (the length of one EDSW) and visually scanned the area in all directions. As monitoring routes were traversed, locations of all priority species were documented using GPS units with at least 5 m accuracy. Only species designated as priority were consistently recorded on monitoring routes. Survey crew members were allowed to record additional IEP species if they were noteworthy.

When a priority IEP was discovered, we recorded the following information: (1) monitoring route, (2) sequential number of the invasion per monitoring route, (3) patch size class (see below), (4) whether the plant was pulled, and (5) 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 apart were considered separate patches and recorded with a separate point.

Patch size class was estimated as follows:

1. 1–3 plants (used for isolated single plants or very small patches of $\leq 2 \times 2$ m),
2. Four 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 m² (>0.25 acre).

We recorded cover class by estimating the amount, or percentage, of ground covered by the vertical projection of plant matter in the patch 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 from a single plant species. Percent 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%)

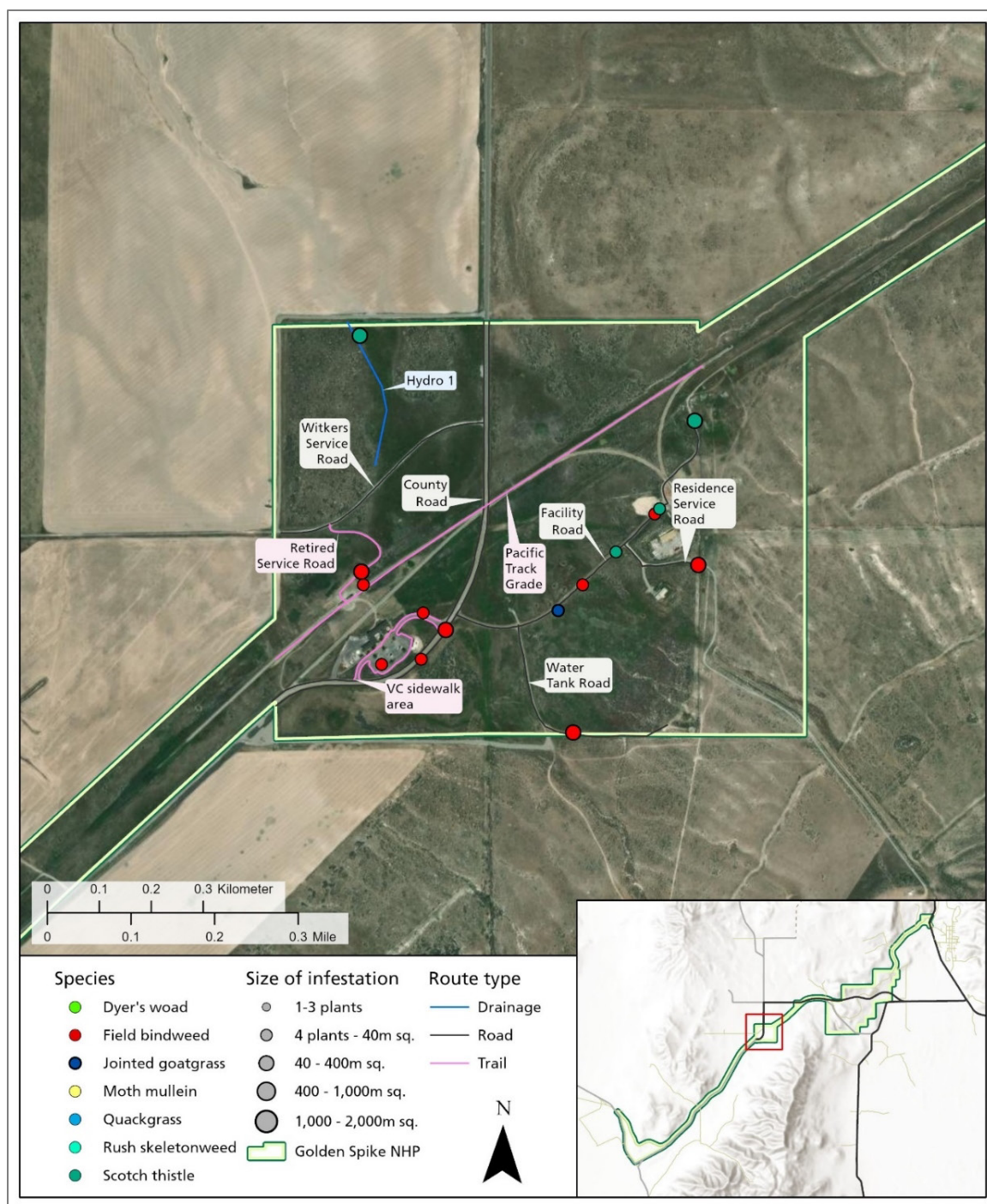


Figure 2. Invasive exotic plant patches detected along monitoring routes, Administrative Area, Golden Spike NHP, June 20–21, 2024.

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We recorded the following ancillary information with every patch: descriptive notes (e.g., hillside, distance to road, wetland, stream); the growth stage of exotic trees (i.e., seedling, sapling, mature

tree, old growth); evidence of prior treatment; and evidence of disturbances (e.g., recent fire, flood, small mammal disturbance).

2.3 Monitoring Transects and Quadrats

The ability to map priority IEPs along routes is inherently subjective because of differences in observer experience and attention to detail. Furthermore, the broad cover classes used in mapping are insufficient to accurately represent the percent cover of an IEP along monitoring routes. To improve consistency in detecting and quantifying IEPs among observers, we supplemented IEP mapping with additional observations along transects.

We established transects with three vegetation quadrats every 500 m along monitoring routes in 2008, 2016, 2018, 2021, and 2024. In 2010, 2012, and 2014, we altered our methods slightly. There were still transects every 500 m. However, if no IEPs were detected for three consecutive transects (9 quadrats), then transects were established every 1,000 m. If invasive plants were found in categories greater than 1 for cover class or patch size class, we resumed establishing transects every 500 m. Transects extended perpendicularly from the edge of a route being walked and on alternating sides of routes consisting of narrow riparian areas, small roads, or trails.

Along each transect, we established up to three 1-m² sampling frames (i.e., quadrats) to quantify vegetation cover and soil surface features. Quadrats were centered at 0.5, 5, and 10 m along the right side of the transect line as the technician walked from the monitoring route. In some cases, quadrats could not be placed at 5 and 10 m due to safety concerns. When necessary, observers leveled the sampling frame by propping up quadrat corners.

In the monitoring quadrats, all priority IEP species observed were recorded. In all years except 2012, cheatgrass and crested wheatgrass were also recorded in transects. Starting in 2014, we also recorded tumble mustard in quadrats.

Plants recorded as present in quadrats include both plants rooted within quadrats and plants rooted outside of, but leaning over, the quadrat frame. 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, 20, 30, 40, 50, 60, 70, 80, 90, 100%. Prior to 2018, cover was recorded 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 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) using the same classes.

2.4 Analyses

We calculated the mean number of patches per kilometer for monitoring routes. Percent cover estimates for monitoring routes or groups of monitoring routes were generated from the monitoring transect data. We calculated the mean and standard error of percent cover by species for monitoring quadrats. Because of differences in observers' knowledge and potential inconsistencies in identifying species not listed on the priority IEP list, only priority species were used when comparing results from year to year.

3 Results

3.1 Priority Invasive Exotic Plant List

In 2024, field crews searched monitoring routes for 24 species identified as priorities at Golden Spike NHP (see Table 1). Observers were trained to recognize priority species but given the freedom to map additional species; therefore, presence and absence data for priority species are reliable for the areas searched, but presence and absence data for other species may be less reliable. We detected 6 priority IEP species, 1 non-priority IEP species, as well as 3 species recorded only in transects in 2024 (Table 2; Figures 3 and 4).

Table 2. Invasive exotic plants detected at Golden Spike National Historical Park, June 20–21, 2024.

Scientific Name	Common Name	Method Detected	Park Priority
<i>Chondrilla juncea</i>	rush skeletonweed	Routes	Yes
<i>Convolvulus arvensis</i>	field bindweed	Routes, Transects	Yes
<i>Isatis tinctoria</i>	dyer's woad	Routes	Yes
<i>Elymus repens</i>	quackgrass	Routes	Yes
<i>Onopordum acanthium</i>	Scotch thistle	Routes	Yes
<i>Verbascum blattaria</i>	moth mullein	Routes	Yes
<i>Agropyron cristatum</i>	crested wheatgrass	Transects	Transects
<i>Bromus tectorum</i>	cheatgrass	Transects	Transects
<i>Sisymbrium altissimum</i>	tumble mustard	Transects	Transects
<i>Aegilops cylindrica</i>	jointed goatgrass	Routes	No

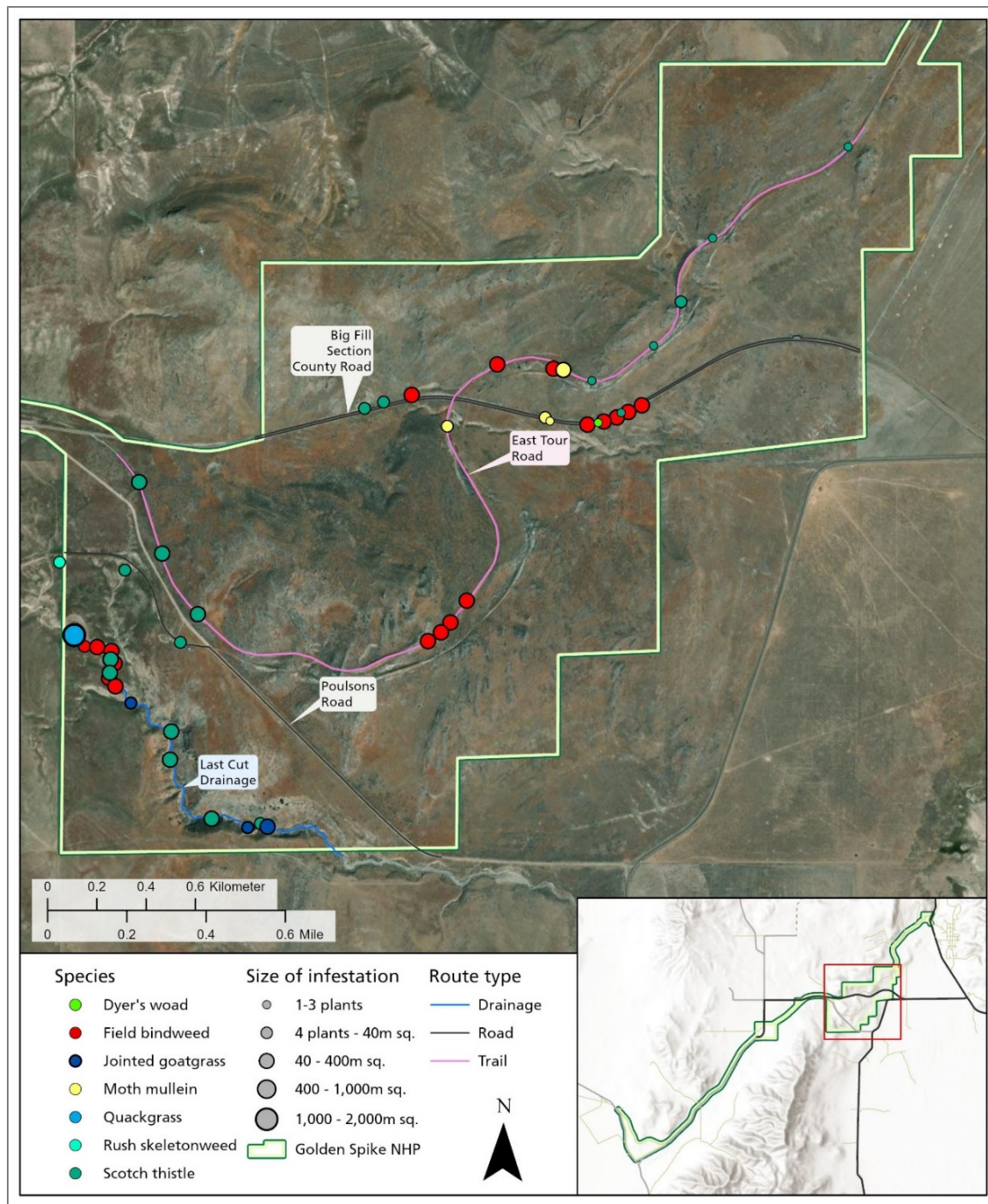


Figure 3. Invasive exotic plant monitoring routes and invasive patches detected along monitoring routes, Big Fill Area, Golden Spike NHP, June 20–21, 2024.

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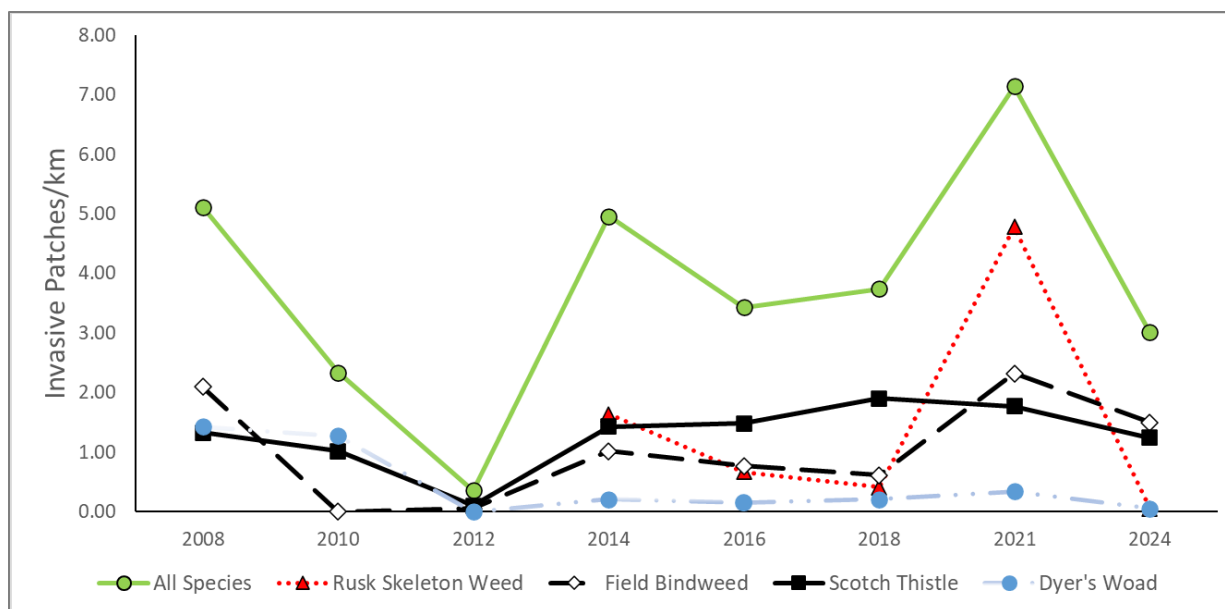


Figure 4. Invasive exotic plants detected per kilometer across Golden Spike NHP in 2008, 2010, 2014, 2016, 2018, 2021, and 2024.

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3.2 Monitoring Routes

In 2024, we recorded six priority IEP species in 60 patches along 20.3 kilometers (12.6 miles) of 12 monitoring routes at Golden Spike NHP (Tables 2 and 3; Figures 3 and 4; NCPN 2025a). The highest densities of plant patches were recorded along the Last Cut Drainage (8.0/km), Facility Road (6.49/km), Residence Service Road (6.11/km), and East Tour Road (3.04/km) (Table 3).

Table 3. Monitoring routes surveyed, route type, length, number of IEP infestations, and number of infestations/km, Golden Spike NHP, June 20–21, 2024.

Route	Type of Route	Length (km)	# of Infestations	Infestations/km
Hydro 1	Riparian	0.29	1	3.40
Last Cut Drainage	Riparian	1.87	15	8.01
Big Fill Section County Road	Roads	5.13	12	2.34
County Road	Roads	1.97	2	1.01
East Tour Road	Roads	5.27	16	3.04
Facility Road	Roads	0.77	5	6.49
Poulsons Road	Roads	2.13	3	1.41
Residence Service Road	Roads	0.16	1	6.11
Retired Service Road	Roads	0.26	1	3.85
Water Tank Road	Roads	0.46	1	2.15
Visitor Center Sidewalk Area	Roads	0.55	2	3.64
Witkers Service Road	Roads	0.46	0	0.00

Table 3 (continued). Monitoring routes surveyed, route type, length, number of IEP infestations, and number of infestations/km, Golden Spike NHP, June 20–21, 2024.

Route	Type of Route	Length (km)	# of Infestations	Infestations/km
Pacific Track Grade	Trail	1.00	1	1.00
All Riparian	Riparian	21.66	16	7.39
All Roads	Roads	17.17	43	2.50
Overall totals	All	20.33	60	3.01

Field bindweed and Scotch thistle (*Onopordum acanthium*) were the most prevalent priority species, representing 88% of all recorded patches (Table 4). Of the 60 patches, 34 (57%) were larger than 40 m². Five additional patches of the non-priority jointed goatgrass (*Aegilops cylindrica*) were located in the Last Cut Drainage (4) and the Facility Road (1).

Table 4. Species observed and infestation size class detected along all monitoring routes, Golden Spike NHP, June 20–21, 2024.

Species	Total # of Infestations	1 to Few Plants	Few Plants–40 m ²	>40–400 m ²	>400–1000 m ²	>1000 m ²
<i>Chondrilla juncea</i>	1	0	1	0	0	0
<i>Convolvulus arvensis</i>	29	0	7	22	0	0
<i>Elymus repens</i>	1	0	0	0	1	0
<i>Isatis tinctoria</i>	1	–	1	0	0	0
<i>Onopordum acanthium</i>	24	5	9	10	0	0
<i>Verbascum blattaria</i>	4	1	2	1	0	0
<i>Aegilops cylindrica</i> ^A	5	0	4	1	0	0
Priority Species, Total	60	7	19	33	1	0

^A Not a priority species so not included in the totals.

3.3 Monitoring Transects

We sampled a total of 39 transects in 2024 (NCPN 2025b). Only one priority species was detected on transects: field bindweed (2 detections). However, all transects were found to contain at least one of the nonpriority transect-only species, crested wheatgrass, cheatgrass, and tumble mustard.

Cheatgrass was the most prevalent species, found in 32 (82%) of transects, with an average cover of 2.47% (SE = 0.77) across all transects. Crested wheatgrass was found in 14 (36%) transects, with an average cover of 1.25% (SE = 0.71) across all transects. Tumble mustard was found in 8 (21%) of transects, with an average cover of 0.20% (SE = 0.11) across all transects. Total percent cover of all species together was 3.90% (SE = 1.02).

3.4 Results Comparison: 2008, 2010, 2012, 2014, 2016, 2018, 2021, and 2024

All roads, trails, and riparian areas surveyed in 2024 were previously surveyed using monitoring routes and quadrats in 2008, 2010, 2012, 2014, 2016, 2018, and 2021 (Perkins 2011, 2013, 2015, 2017, 2022; Perkins and Weissinger 2009; Washuta and Perkins 2019). For IEP species consistently monitored from 2008 to 2024, there was a decrease in IEP patches in 2024, when 3.01 patches/km were found, compared to 7.14 patches/km in 2021. The number detected in 2018 was the highest total detected during the entire sampling period from 2008 to 2024 (Table 5, Figure 4). This decrease was largely driven by rush skeletonweed (*Chondrilla juncea*), which decreased from 4.78 patches/km in 2021 to 0.05 patches/km in 2024. Scotch thistle, field bindweed, and dyer's woad (*Isatis tinctoria*) also had small decreases from 2021 to 2024 (see Figure 4).

Table 5. Monitoring routes surveyed by species, year, total patches, and patch size class, Golden Spike NHP, June 20–21, 2024. Note that total numbers do not match numbers in Table 4 because *Convolvulus arvensis* and *Rumex crispus* were removed from totals since they were not a priority species in all sampling periods.

Common Name Scientific name	Year	Total Patches	Patch Size Class ^A				
			1	2	3	4	5
diffuse knapweed <i>Centaurea diffusa</i>	2008	0	0	0	0	0	0
	2010	0	0	0	0	0	0
	2012	0	0	0	0	0	0
	2014	0	0	0	0	0	0
	2016	1	1	0	0	0	0
	2018	8	7	1	0	0	0
	2021	0	0	0	0	0	0
	2024	0	0	0	0	0	0
rush skeletonweed <i>Chondrilla juncea</i>	2008	0	0	0	0	0	0
	2010	0	0	0	0	0	0
	2012	0	0	0	0	0	0
	2014	32	14	9	4	2	3
	2016	13	10	3	0	0	0
	2018	8	7	1	0	0	0
	2021	88	14	30	16	15	13
	2024	1	0	1	0	0	0
field bindweed <i>Convolvulus arvensis</i>	2008	41	5	15	14	5	2
	2014	20	0	17	2	1	0
	2016	15	1	13	1	0	0

^A Patch size classes: 1 = 1–3 plants ($\leq 2 \times 2$ m), 2 = 4 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).

^B Does not include *Convolvulus arvensis*, which was not on the priority list in 2010 or 2012.

Table 5 (continued). Monitoring routes surveyed by year, species, length, number of priority IEP infestations, and number of infestations/km, Golden Spike NHP, June 20–21, 2024. Note that total numbers do not match numbers in Table 4 because *Convolvulus arvensis* and *Rumex crispus* were removed from totals since they were not a priority species in all sampling periods.

Common Name Scientific name	Year	Total Patches	Patch Size Class ^A				
			1	2	3	4	5
field bindweed <i>Convolvulus arvensis</i> (continued)	2018	12	0	6	5	1	0
	2021	52	0	22	18	8	4
	2024	29	0	7	22	0	0
dyer's woad <i>Isatis tinctoria</i>	2008	28	20	4	3	1	0
	2010	25	12	5	5	1	2
	2012	0	0	0	0	0	0
	2014	4	2	0	1	1	0
	2016	3	1	2	0	0	0
	2018	4	3	1	0	0	0
	2021	7	4	0	3	0	0
	2024	1	1	0	0	0	0
Scotch thistle <i>Onopordum acanthium</i>	2008	26	8	8	10	0	0
	2010	20	7	6	6	1	0
	2012	2	1	1	0	0	0
	2014	28	6	10	7	1	4
	2016	29	11	16	2	0	0
	2018	37	13	19	3	2	0
	2021	38	11	17	6	4	0
	2024	24	5	9	10	0	0

^A Patch size classes: 1 = 1–3 plants ($\leq 2 \times 2$ m), 2 = 4 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).

^B Does not include *Convolvulus arvensis*, which was not on the priority list in 2010 or 2012.

Table 5 (continued). Monitoring routes surveyed by year, species, length, number of priority IEP infestations, and number of infestations/km, Golden Spike NHP, June 20–21, 2024. Note that total numbers do not match numbers in Table 4 because *Convolvulus arvensis* and *Rumex crispus* were removed from totals since they were not a priority species in all sampling periods.

Common Name Scientific name	Year	Total Patches	Patch Size Class ^A				
			1	2	3	4	5
moth mullein <i>Verbascum blattaria</i>	2008	0	0	0	0	0	0
	2010	1	0	0	1	0	0
	2012	4	0	2	2	0	0
	2014	6	3	2	0	0	1
	2016	6	0	0	1	2	3
	2018	10	0	1	0	3	6
	2021	7	4	0	1	1	1
	2024	4	1	2	1	0	0
Total priority species ^B	2008	59	30	13	15	1	0
	2010	46	19	11	12	2	2
	2012	6	1	3	2	0	0
	2014	77	26	23	15	6	7
	2016	52	23	21	3	2	3
	2018	61	23	23	4	5	6
	2021	141	33	50	24	20	14
	2024	30	7	12	11	0	0

^A Patch size classes: 1 = 1–3 plants ($\leq 2 \times 2$ m), 2 = 4 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).

^B Does not include *Convolvulus arvensis*, which was not on the priority list in 2010 or 2012.

The average percent cover of crested wheatgrass has declined across the park, from 6.4% in 2008 to 1.25% in 2024 (Figure 5). Cheatgrass has varied widely in average percent cover over the last five visits, ranging from 11.27% in 2018 to 1.07% in 2021, and it was at 2.47% in 2024. In contrast, the percent of transects in which crested wheatgrass, cheatgrass, and tumble mustard were detected has shown little change across all sampling years (Figure 6).

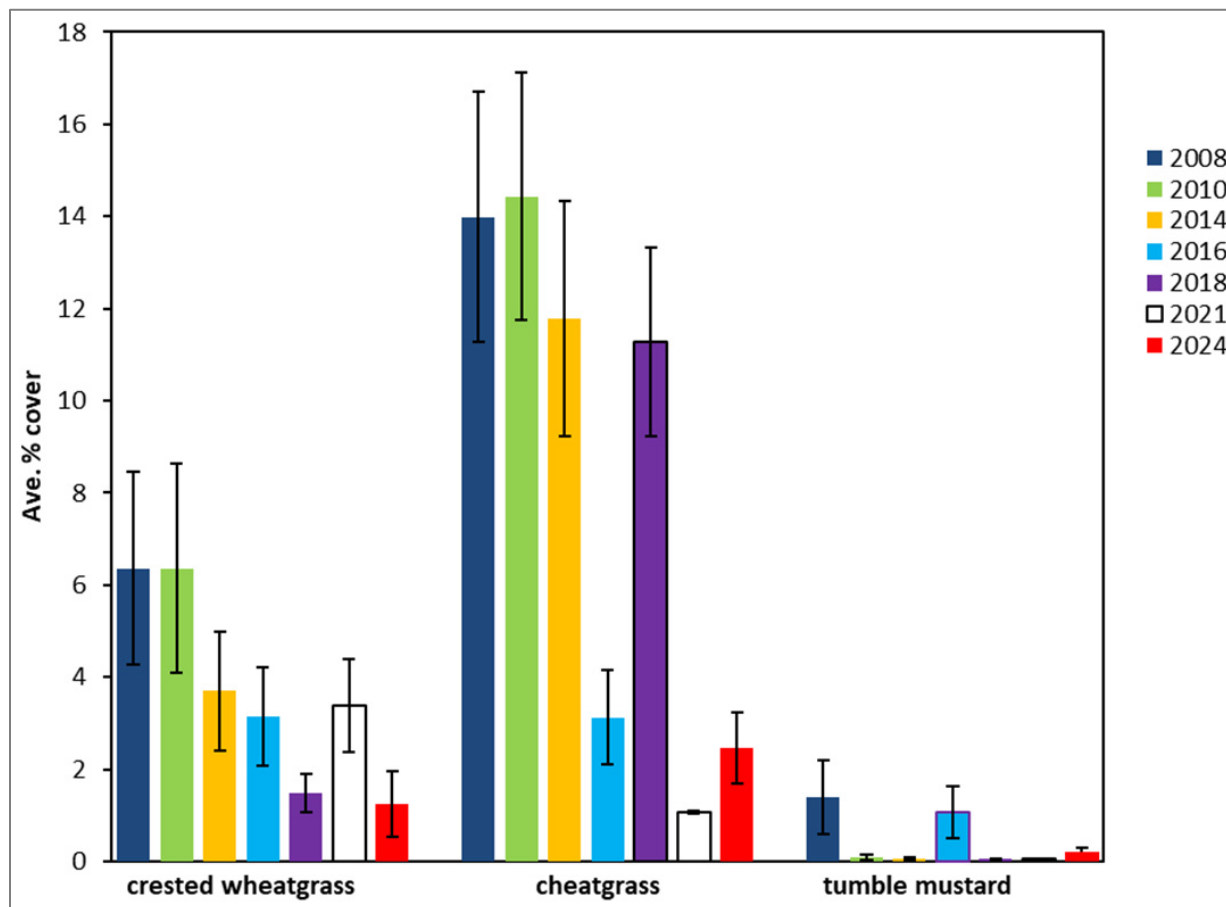


Figure 5. Percent cover with standard error of invasive species that were consistently recorded in transects at Golden Spike NHP in 2008, 2010, 2014, 2016, 2018, 2021, and 2024.

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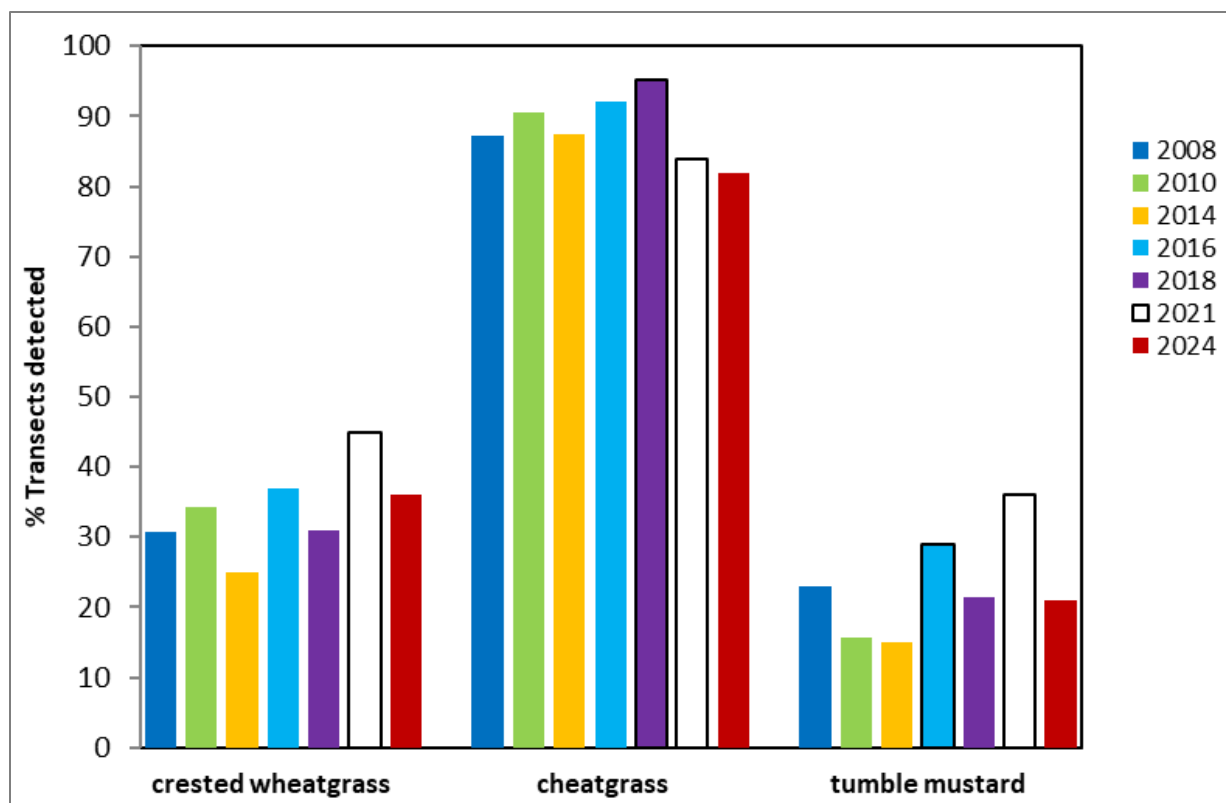


Figure 6. Percent of transects in which three common IEPs were recorded at Golden Spike NHP in 2008, 2010, 2014, 2016, 2018, 2021, and 2024.

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4 Discussion

The NCPN will continue to work with park staff and area IEP experts to review and update the list of priority species prior to each field visit. Presence and absence data for priority IEP species should be reliable for the area surveyed. NCPN has no recommendations to add to the priority IEP list for future years.

The two riparian routes surveyed in the park, Hydro 1 and Last Cut drainages, continue to be some of the hotspots for priority IEP patches, particularly the Last Cut Drainage, which had the highest number of patches/km of any monitoring route. The highest density of patches not on drainages occurred on the Facility Road, Residence Service Road, and East Tour Road.

The number of priority IEP patches for species consistently monitored at Golden Spike NHP since 2008 decreased to 60 in 2024, compared to 141 patches in 2021 (Table 5, Figure 4). This decrease was largely driven by rush skeletonweed. Field bindweed was not included in the total numbers because it has not been a priority species in all samples, but it also decreased dramatically—from 52 patches in 2021 to 29 in 2024.

Rush skeletonweed, quackgrass, dyer's woad, and moth mullein (*Verbascum blattaria*) were all detected in fewer than 5 patches in 2024. These species are good candidates for control due to the infrequent number of patches. Russian knapweed was not detected in 2024, demonstrating the success of past control efforts on this species.

Percent frequency of cheatgrass, crested wheatgrass, and tumble mustard has not changed dramatically across sampling years (Figure 6). These species remain widespread, with at least one of these species present in every transect sampled in 2024. Percent cover of cheatgrass was similar to 2021 but was much lower than in 2018. This species can vary widely in response to precipitation. Percent cover of crested wheatgrass decreased from 2021 and was similar to cover in 2018 (Figure 6). Percent cover of tumble mustard has been consistently very low, due in part to its skeletal architecture, but this species is regularly found in transects across the park (Figure 6).

It should be noted that estimates of percent cover in this report are limited to the routes surveyed. Actual percent cover of IEPs across the entire park cannot be determined with these methods. It is likely that the percent cover for most IEP species is lower in the interior of the park than along the monitoring routes because we have chosen to monitor along areas most likely to be invaded by a broad suite of IEPs.

The monitoring crew also noted the presence of the following species that are not on the priority invasive plant list or monitored in transects:

- High amounts of: stork's bill (*Erodium cicutarium*)
- Moderate amounts of: ripgut brome (*Bromus diandrus*), bulbous bluegrass (*Poa bulbosa*), yellow sweet-clover (*Melilotus officinalis*), Bur buttercup (*Ceratocephala testiculata*),

prickly lettuce (*Lactuca serriola*), summer-cypress (*Bassia scoparia*), Russian-thistle (*Salsola tragus*)

- Sparse amounts of: halogeton (*Halogeton glomeratus*), yellow salsify (*Tragopogon dubius*), Japanese chess (*Bromus japonicus*), yard knotweed (*Polygonum aviculare*), flaxweed (*Descurainia sophia*), desert madwort (*Alyssum desertorum*), African mustard (*Malcolmia africana*)

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. The network will continue to collect data on tumble mustard, cheatgrass, and crested wheatgrass in transects only.

IEPs at Golden Spike NHP 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 through September is not expected to substantially alter the chances of detecting IEP patches larger than the minimum detection target size. 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.

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National Park Service
U.S. Department of the Interior



Science Report NPS/SR—2025/352
<https://doi.org/10.36967/2315453>

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