National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Invasive Exotic Plant Monitoring in Capitol Reef National Park

2019 Field Season, Scenic Drive and Cathedral Valley Road

Natural Resource Report NPS/NCPN/NRR—2021/2265



ON THE COVER

Cathedral Valley in Capitol Reef National Park. NPS/Amy Washuta

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June 2021

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Please cite this publication as:

Fahey, K., and D. W. Perkins. 2021. Invasive exotic plant monitoring in Capitol Reef National Park: 2019 field season, Scenic Drive and Cathedral Valley Road. Natural Resource Report NPS/NCPN/NRR—2021/2265. National Park Service, Fort Collins, Colorado. https://doi.org/10.36967/nrr-2286627.

NPS 158/176577, June 2021

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Executive Summary

Invasive exotic plant (IEP) species are a significant threat 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 11 monitoring protocols to be implemented as part of its long-term monitoring program. From May 30 to June 1, 2019, network staff conducted surveys for priority IEP species along the Scenic Drive and Cathedral Valley Road monitoring routes at Capitol Reef National Park. We detected 119 patches of six priority IEP species along 34 kilometers of the two monitoring routes. There were more patches of IEPs, and a higher percentage of large patches, than in previous years. This indicates that previously identified infestations have expanded and grown. The most common (47.1%) patch size among priority species was 1,000–2,000 m^2 (0.25–0.5 acre). The vast majority (93.2%) of priority patches ranked either low (58.8%) or very low (34.4%) on the patch management index scale. Tamarisk (*Tamarix* sp., 72 patches) was the most prevalent priority IEP species. African mustard (*Malcolmia africana*, 32 patches), field bindweed (*Convolvulus arvensis*, 9 patches), and Russian olive (*Elaeagnus angustifolia*, 3 patches) occurred less commonly. Together, these four species represented 97.5% of all patches recorded in 2019. Four IEP species were found on the monitored routes for the first time: Russian olive (*Elaeagnus angustifolia*), quackgrass (*Elymus repens*), Siberian elm (*Ulmus pumila*), and African mustard (*Malcolmia africana*, not on the priority species list before 2019). Cathedral Valley Road had higher IEP priority patches per kilometer (5.68) than the Scenic Drive (2.05). IEP species were found on 37.9% (25 of 66) of monitored transects. Almost all these detections were Russian thistle (*Salsola* sp.). Russian thistle was widespread, present in 33.3% of transects, with an estimated cover of 0.2% across all transects sampled. Across routes monitored in all three rotations (2012, 2015, and 2019), Russian thistle has increased in frequency. However, its frequency remained about the same from 2015 to 2019, and percent cover remains low. Tamarisk and field bindweed have both increased in prevalence since monitoring began, with tamarisk showing a dramatic increase in the number and size of patches. Immediate control of tamarisk and these other species is recommended to reduce their numbers on these routes. The NCPN plans to return to Capitol Reef in 2020 to monitor Oak and Pleasant creeks, completing the third rotation of invasive plant monitoring.

Acknowledgements

A. Wight was extremely helpful in generating routes, transects, and other GIS information. J. Roche and S. Borthwick assisted with reviewing the park's target invasive plant list and arranging site logistics. Field work was conducted by A. Washuta, L. Gommermann, L. Johnston, and K. Griffen. R. Weissinger improved this report with her thoughtful review. Data management was provided by H. Thomas and B. Campbell. M. Schrade assisted with administrative and logistical 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 (Loope 1992). 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 priority IEPs in parks along key invasive pathways. Priority IEPs are a subset of species that are either present and potentially controllable at a park or have not been detected at a park but could soon become present due to their existence in surrounding areas. Park and network staff re-evaluate the list of these species before each monitoring season.

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. The consequences of these plant invasions present a significant challenge to the National Park Service's ability to maintain natural resources "unimpaired for the enjoyment of future generations."

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. Instead, we select monitoring routes 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. At Capitol Reef National Park (NP), it takes 3–5 years to complete a full rotation of the standard monitoring routes, depending on staff and funding.

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; and
2. To determine status and trends of selected invasive plant populations of management significance.

This report summarizes the 2019 field season along the Scenic Drive and Cathedral Valley Road monitoring routes at Capitol Reef NP. This is the penultimate part of the third rotation of monitoring routes at Capitol Reef.

2 Methods

We followed the invasive exotic plant monitoring protocol developed by the NCPN (Perkins et al. 2016), adapted from Andersen and Dewey (2007). The protocol emphasizes the quick collection of IEP location and abundance data in order to maximize the amount of area searched, thus increasing the chances of finding a higher percentage of both new and established invasions. 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).

2.1 Developing a park target invasive exotic plant list

Prior to beginning monitoring in 2019, NCPN and Capitol Reef NP staff reviewed the park's list of priority IEPs (Table 2-1). The list was developed by reviewing past park literature and state and county weed lists, and consulting with park staff and county weed managers. It includes existing IEPs and potential IEPs of high management concern, and is reviewed before each field season. In 2019, jointed goatgrass (*Aegilops cylindrica*) and madder (*Rubia tinctoria*) were added to the target list. Additionally, the search for *Cardaria draba* (hoary cress) was broadened to all species of *Cardaria* (whitetop). Cheatgrass (*Bromus tectorum*), Russian thistle (*Salsola* sp.), and crested wheatgrass (*Agropyron cristatum*) were all searched for consistently in transects but not mapped along monitoring routes.

Because these methods are designed to be rapid, field crews are trained to develop a focused search image of the target plants, instead of looking for every possible invasive plant species. The likelihood of eradicating these target species, or containing them within a park, is generally high.

2.2 Monitoring routes

2.2.1 Minimum detection target size

The minimum detection target size (MDTS) represents the patch size that is large enough to be detected with a high level of confidence (typically at least 90% of the total number of patches of that size and larger in the monitoring area) under actual field conditions, but small enough so that any missed patches smaller than the MDTS could still feasibly be eradicated if not found until the next scheduled monitoring visit. We established an MDTS of 40 m^2 (0.01 acres or approximately 20 × 20 ft) for all IEPs. Use of the MDTS was necessary because field technicians are not expected to find every single plant of every targeted IEP species during route surveys. Searching for single mature

Table 2-1. Priority invasive exotic plant list, Capitol Reef NP, 2009–2019.

Scientific name	Common name	On list in 2019?
Aegilops cylindrica[A]	jointed goatgrass	Y
Ailanthus altissima	tree-of-heaven	Y
Arctium minus	burdock	Y
Asparagus officinalis	asparagus	Y
Cardaria sp.[A]	whitetop	Y
Cardaria draba[B]	hoary cress	N
Carduus acanthoides[C]	plumeless thistle	N
Carduus nutans[A]	musk thistle	Y
Centaurea diffusa	diffuse knapweed	Y
Centaurea maculosa	spotted knapweed	Y
Centaurea repens	Russian knapweed	Y
Cirsium arvense	Canada thistle	Y
Cirsium vulgare	bull thistle	Y
Convolvulus arvensis	field bindweed	Y
Cynoglossum officinale[D]	common houndstongue	Y
Elaeagnus angustifolia	Russian olive	Y
Elymus repens	quackgrass	Y
Euphorbia esula	leafy spurge	Y
Hyoscyamus niger[D]	black henbane	Y
Isatis tinctoria	Dyer's woad	Y
Lythrum salicaria	purple loosestrife	Y
Malcolmia africana[E]	African mustard	Y
Marrubium vulgare	horehound	Y
Medicago sativa[F]	alfalfa	N
Onopordum acanthium	Scotch thistle	Y
Rubia tinctoria[A]	madder	Y
Tamarix sp.	tamarisk	Y
Ulmus pumila	Siberian elm	Y
Verbascum thapsus	woolly mullein	Y

[A]Added in 2019; [B]2009–2016 only; [C]2009–2011 only; [D]Added in 2012; [E]2012–2013, 2016, 2019; [F]2009–2010 only

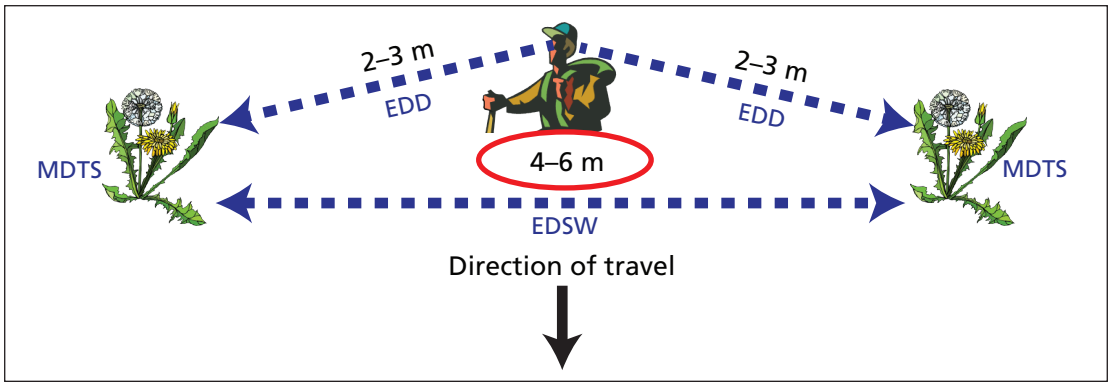


Figure 2-1. The maximum effective detection distance (EDD) at Capitol Reef National Park was 2–3 meters in 2019, making the effective detection swath width (EDSW) 4–6 meters.

plants of some species, such as Russian olive (*Elaeagnus angustifolia*) and Siberian elm (*Ulmus pumila*), is possible due to their large size. Single plants of other species, such as madder (*Rubia tinctoria*), are very difficult to detect in most field conditions unless the observer is very close to the patch.

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). Using fake plants of a targeted size, crew members are trained by walking away and determining the maximum distance from which they can 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 Capitol Reef NP in 2019 was 2–3 meters.

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 (see Figure 2-1). The effective detection swath width (EDSW) is equal to two times the EDD, because the surveyor can effectively detect IEPs for one EDD on either side of his/her search route. The EDSW for Capitol Reef NP in 2019 was 4–6 meters.

2.2.4 Patch separation resolution

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

2.2.5 Between feature position

Between feature positions allow electronic tracking of a user's route. A GPS (global positioning system) unit is 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 have established a four-year rotation of monitoring routes at Capitol Reef NP that covers Highway 24, the Pleasant Creek cattle trail, Oak Creek cattle trail, the Scenic Drive, and Cathedral Valley Road monitoring routes (Table 2-2). In 2019, NCPN staff visited the Scenic Drive and Cathedral Valley

Road monitoring routes (Figure 2-2) for the third time. We had planned to monitor the Oak Creek cattle trail as well, but postponed this work because a cattle drive was occurring at the time of sampling.

Along the Scenic Drive and Cathedral Valley Road, observers walked out on one side of the road and walked back on the other. While walking, we searched for IEPs by visually scanning (side-to-side) all the land within the borders of the swath. If the terrain was uneven or steep, and an observer had to glance frequently at the ground to ensure safe foot placement, then they stopped approximately every 10 meters (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 GPS units with at least five-meter accuracy. Only priority species were consistently recorded during monitoring routes. Crew members were permitted to record additional species if they were noteworthy.

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) patch size class (see below), (4) whether the plant was pulled by the observer, 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 meters (55 yards) apart were considered separate invasions and recorded with separate points. Patch size class was estimated as follows:

1. 1–3 plants (used for isolated single plants or very small patches (≤2 × 2 m),
2. 4 plants–40 m^2 (48 yd^2),
3. 40–400 m^2 (48–478 yd^2),
4. 400–1,000 m^2 (0.1–0.25 acre), and
5. 1,000–2,000 m^2 (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 patch: descriptive notes (e.g., hillside, distance to road, wetland, stream), the growth stage of exotic trees (e.g., sapling, pole, mature), evidence of prior treatment, and evidence of disturbances (e.g., recent fire, flood, small mammal disturbance).

Table 2-2. Rotation of invasive exotic plant monitoring routes at Capitol Reef National Park, 2009–2019.

Year	Monitoring routes
2009	Highway 24
2010	Highway 24/Pleasant Creek
2011	Oak Creek
2012	Cathedral Valley Road/Scenic Drive
2013	Highway 24
2014	Pleasant Creek
2015	Oak Creek/Cathedral Valley Road/Scenic Drive
2016	Highway 24/Pleasant Creek
2017	No monitoring
2018	No monitoring
2019	Cathedral Valley Road/Scenic Drive

2.3 Monitoring transects

2.3.1 Transect and quadrat establishment

We established transects with three vegetation quadrats every 500 meters along monitoring routes (Figures 2-3 and 2-4). Quadrats were centered at 0.5, 5, and 10 meters away from the edge of the road on the same side as the route being walked. A 1-m^2 sampling frame, used to sample vegetation cover and soil-surface features, was placed on the right side of the transect line as the technician

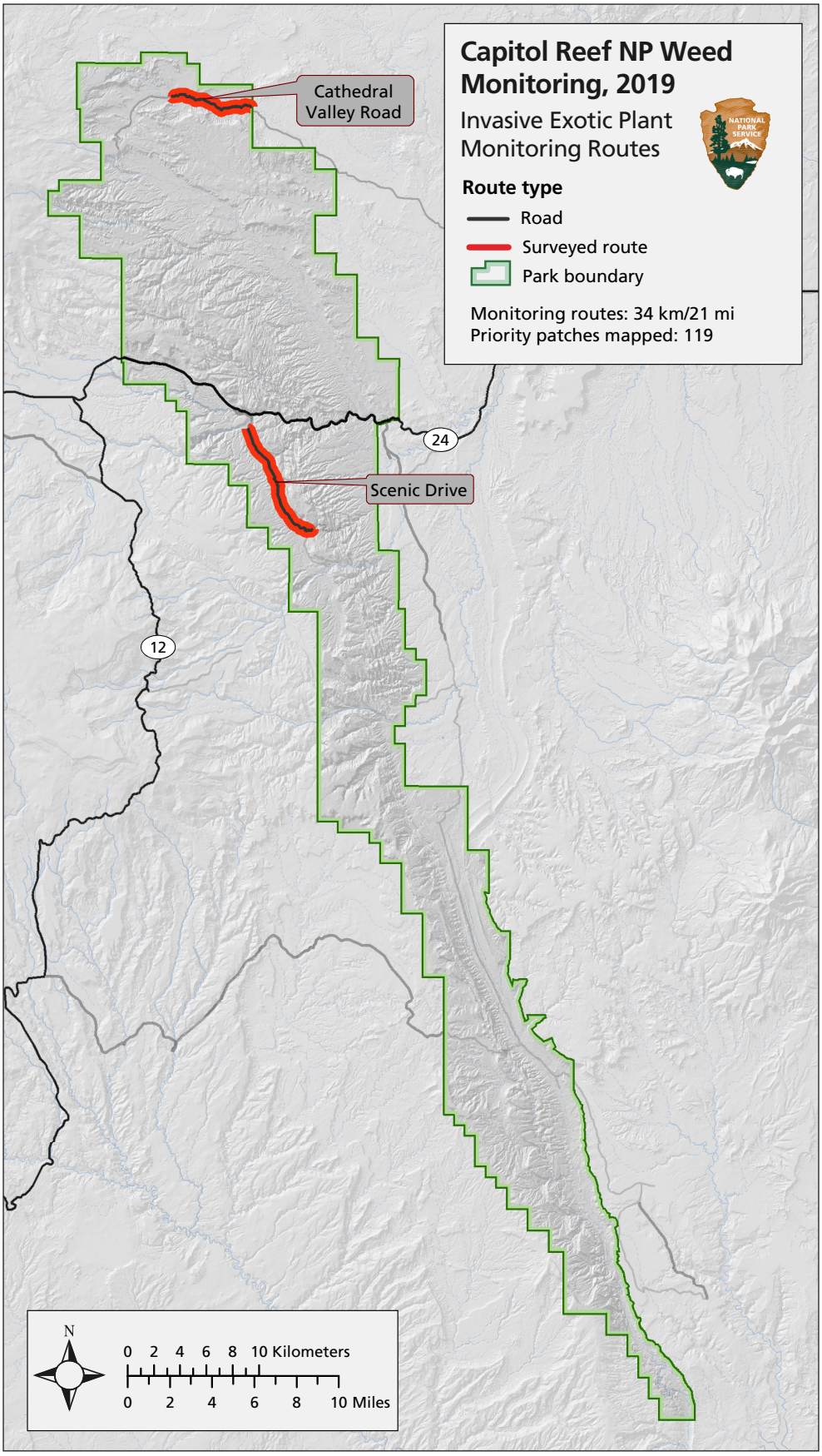


Figure 2-2. Invasive plant monitoring routes monitored in 2019, Capitol Reef National Park, May 30–June 1, 2019.

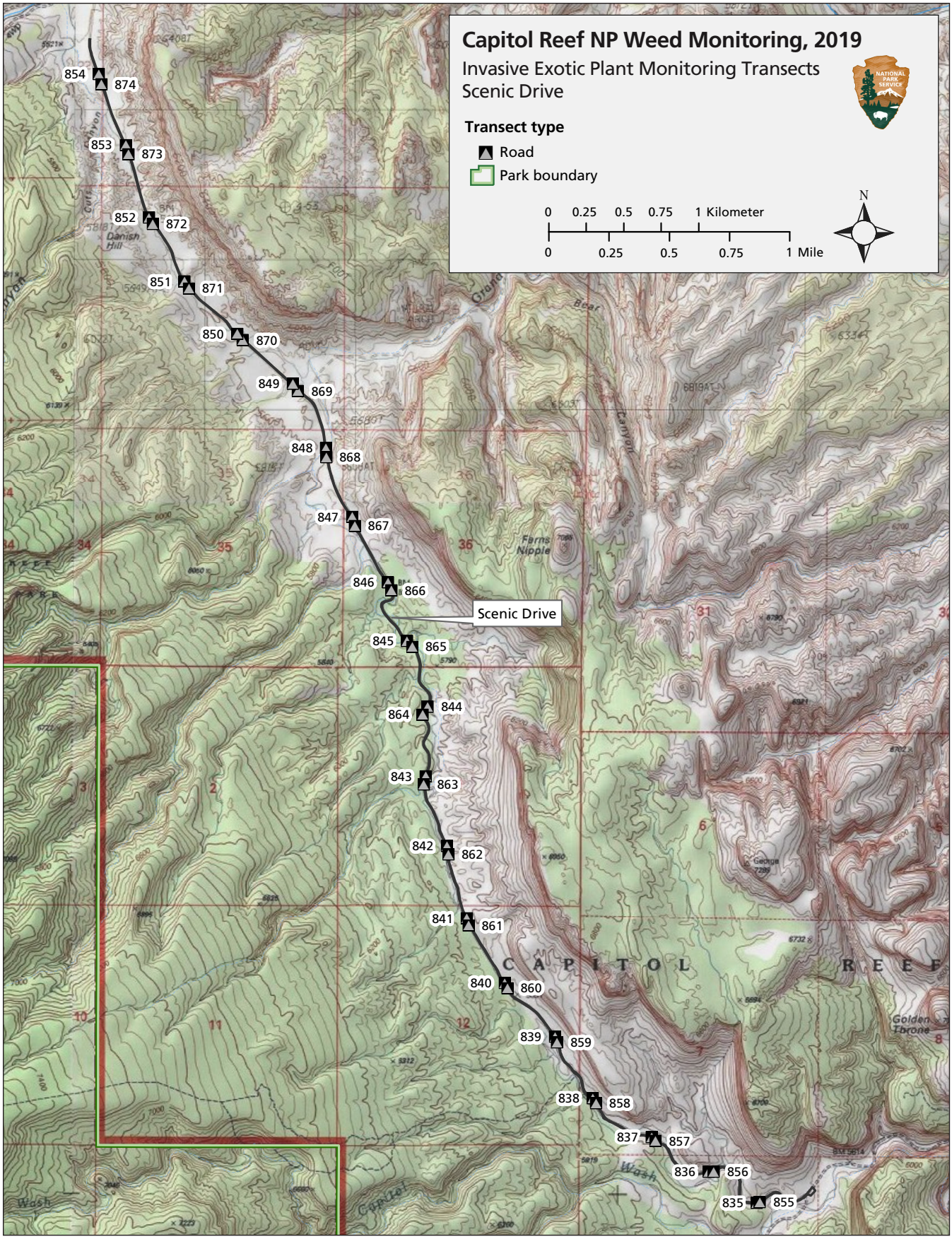


Figure 2-3. Transect locations along the Scenic Drive, Capitol Reef National Park, May 30–June 1, 2019.

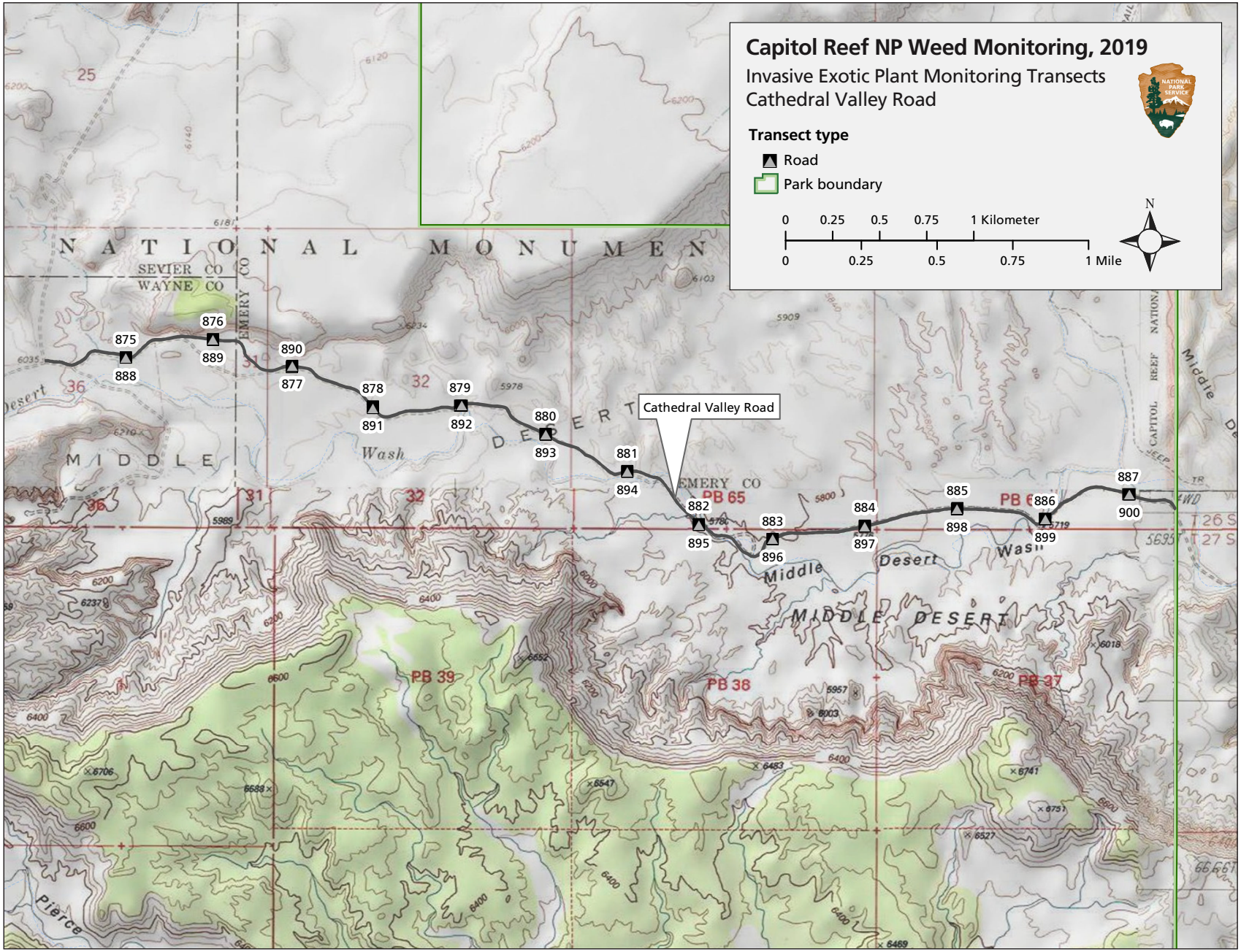


Figure 2-4. Transect locations along Cathedral Valley Road, Capitol Reef National Park, May 30–June 1, 2019.

walked the monitoring route. In some cases, we leveled the sampling frame by propping up quadrat corners.

2.3.2 Data collection methods

All priority IEP species observed on monitoring routes were also recorded in the monitoring quadrats, along with cheatgrass (*Bromus tectorum*), crested wheatgrass (*Agropyron cristatum*), and Russian thistle (*Salsola* sp.). 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, or 100%. We also recorded percent cover to the nearest 10% of 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 patches per kilometer 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. Due to differences in observers' knowledge, only priority species should be used when comparing results from year to year.

We developed a patch management index (PMI) to quantify both the extent and density of a patch into a single value that helps identify the scale of the problem. Park managers will be able to use this tool to help prioritize IEP treatment. PMI was determined using the following formula:

Patch size class (1–5) × Patch percent cover (1–5) = Patch management index (1–25)

We then grouped the PMI into five classes:

1. Very low (1–5)
2. Low (6–10)
3. Moderate (11–-15)
4. High (16–20)
5. Very high (21–25)

Patches with a low or very low PMI score will generally be easier to control or remove than patches with a high or very high PMI. In many cases, directing resources toward controlling patches with low or very low PMI can be a highly effective management strategy; the goal of early detection is to allow managers to eliminate patches before they can grow into bigger problems. Other times, a species with many inventoried patches that are mostly low or very low in PMI may or may not be easier to treat (and possibly eradicate) than a different species that has a few inventoried patches that are high or very high in PMI. Therefore, park managers should consider PMI within the context of information on species and patch numbers when prioritizing treatment.

3 Results

3.1 Target invasive exotic plant list

There were 26 IEP species on the priority list for Capitol Reef NP in 2019 (see Table 2-1). Observers are 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 absence data for non-priority species are suspect. In addition, although not mapped along monitoring routes, cheatgrass (*Bromus tectorum*) and Russian thistle (*Salsola* sp.) were recorded consistently in systematic transects.

We recorded a total of six priority IEP species on monitoring routes and three in transects in 2019 (Table 3-1). Two additional non-priority exotic species were recorded in three patches on monitoring routes. We covered 34.1 kilometers (21.2 miles) of monitoring routes, an area of 18.1 hectares. We completed 66 transects along monitoring routes.

3.2 Monitoring routes

We surveyed the Scenic Drive and Cathedral Valley Road monitoring routes in 2019 as part of the third monitoring rotation at Capitol Reef NP. A total of 119 patches of six priority species were detected (Table 3-2, Figures 3-1 to 3-4, Appendix A). The most common patch size was 1,000–2,000 m^2 (0.25–0.5 acre), accounting for 47.1% of priority-species patches. Most (58.8%) patches of priority species ranked low on the patch management index scale, with an additional 34.4% ranking very low. The rest (6.7%) ranked medium.

Tamarisk (*Tamarix* sp.)was the most prevalent priority species on monitoring routes. With a total of 72 patches recorded, tamarisk represented 60.5% of all priority patches (Tables 3-3 and 3-4). Most (55 of 72) tamarisk infestations had low PMI scores. The remainder scored very low or medium. The next-most common priority species were African mustard (*Malcolmia africana*), field bindweed (*Convolvulus arvensis*), and

Table 3-1. Invasive exotic plants detected at Capitol Reef NP, May 30–June 1, 2019.

Scientific name	Common name	Method detected		Priority?
		Routes	Transects	
Convolvulus arvensis	field bindweed	Y	N	Y
Elaeagnus angustifolia	Russian olive	Y	N	Y
Elymus repens	quackgrass	Y	N	Y
Malcolmia africana	African mustard	Y	Y	Y
Tamarix sp.	tamarisk	Y	N	Y
Ulmus pumila	Siberian elm	Y	N	Y
Bromus tectorum	cheatgrass	N	Y	Transect only[A]
Salsola sp.	Russian thistle	N	Y	Transect only[A]
Chorispora tenella	blue mustard	Y	N	N
Sisymbrium altissimum	tumble mustard	Y	N	N

[A]Transect-only species are recorded only in transects. They are not recorded along monitoring routes.

Table 3-2. Number of patches by route, Capitol Reef NP, May 30–June 1, 2019.

Route	Route type	Length (km)	Total patches	Total IEP priority patches	IEP priority patches/km
Cathedral Valley Road	Road	13.6	77	77	5.7
Scenic Drive	Road	20.5	45	42	2.0

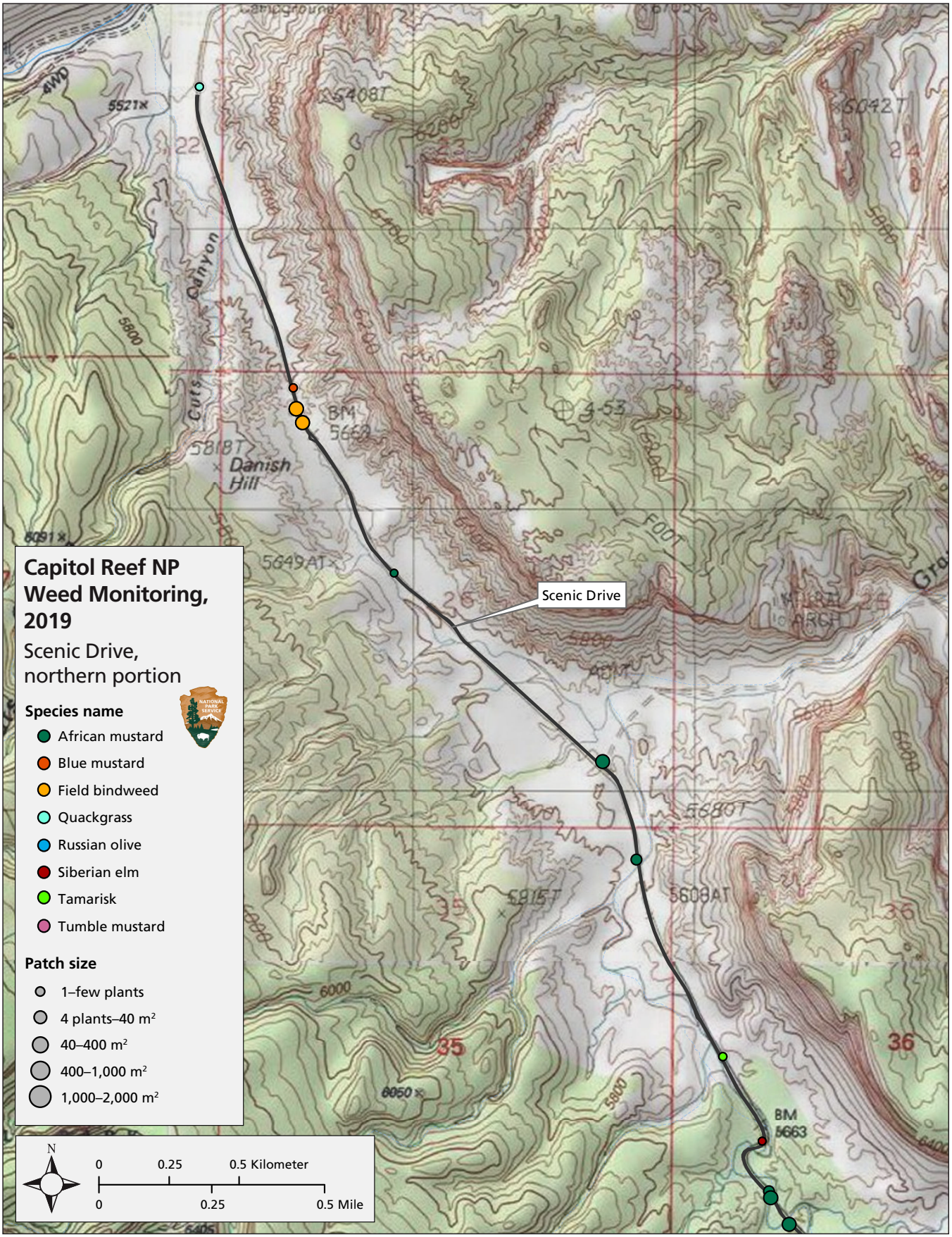


Figure 3-1. Invasive plants detected along the northern portion of the Scenic Drive, Capitol Reef National Park, May 30–June 1, 2019.

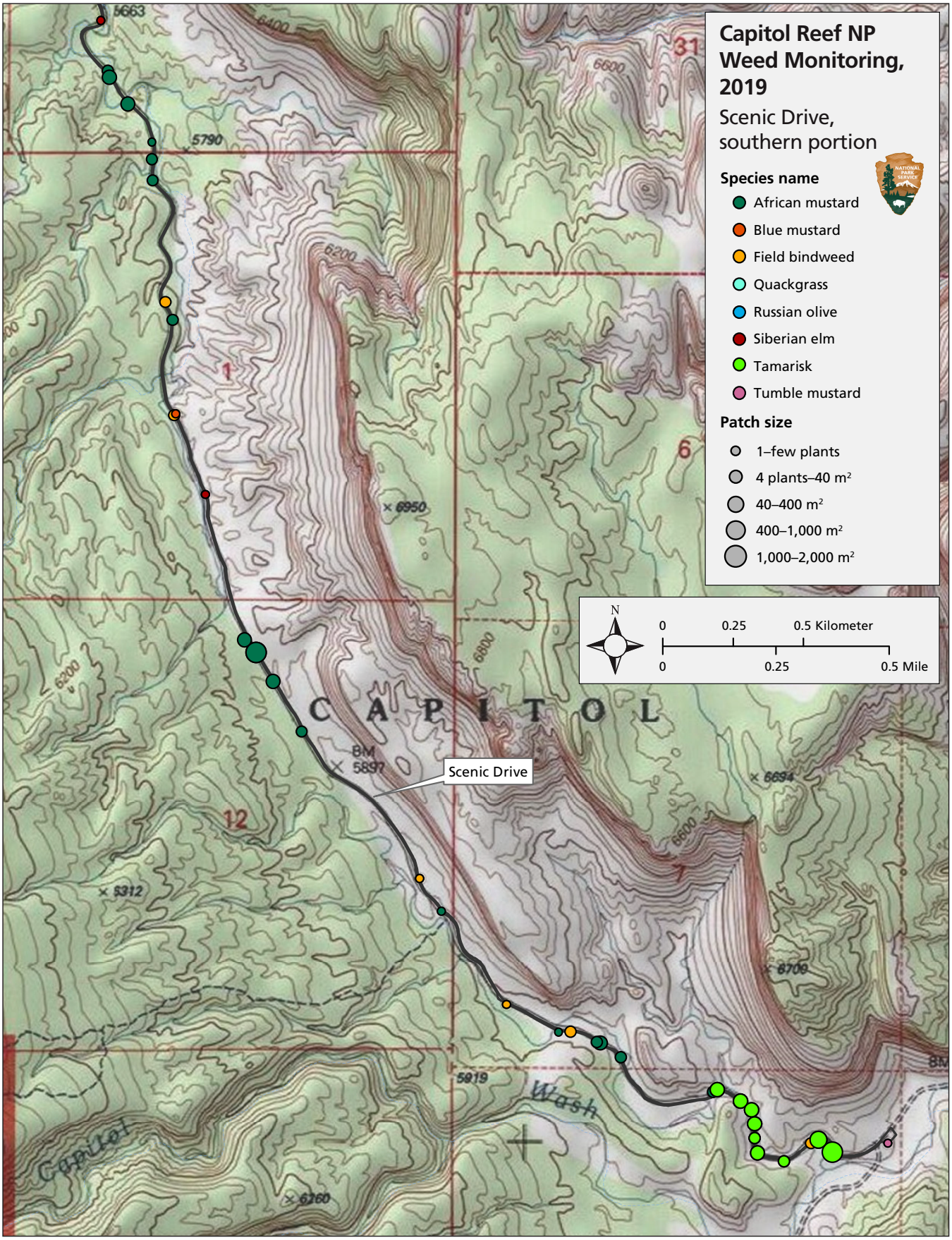


Figure 3-2. Invasive plants detected in the southern portion of the Scenic Drive, Capitol Reef National Park, May 30–June 1, 2019.

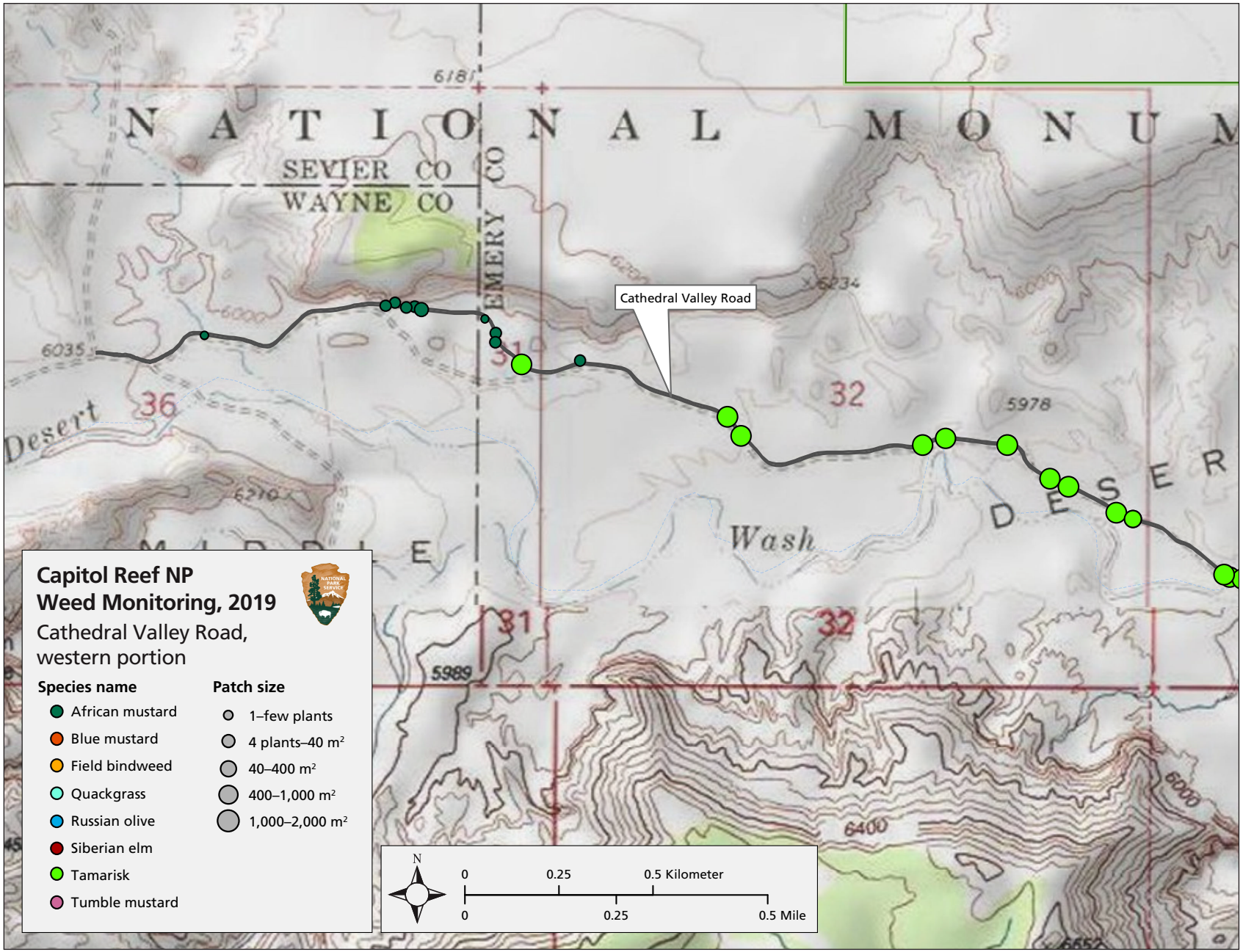


Figure 3-3. Invasive plants detected along the western portion of the Cathedral Valley Road, Capitol Reef National Park, May 30–June 1, 2019.

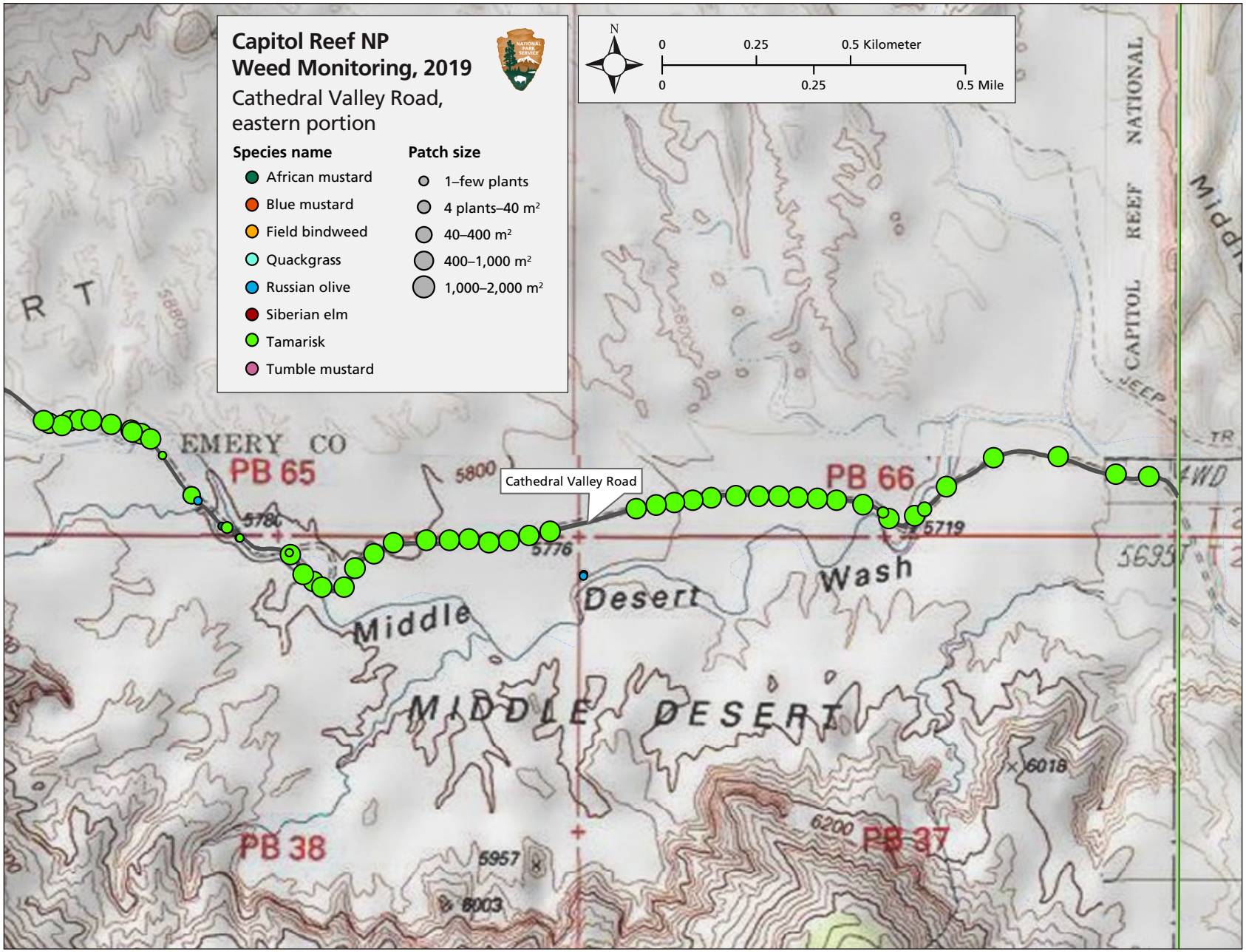


Figure 3-4. Invasive plants detected in the eastern portion of Cathedral Valley Road, Capitol Reef National Park, May 30–June 1, 2019.

Table 3-3. Number of priority patches by species, patch size class, and patch management index detected along the Scenic Drive in Capitol Reef NP, 2012, 2015, and 2019.

Scientific name	Common name	Year	Patch type		Patch size class[A]					Patch management index[B]				
			Priority	Total	1	2	3	4	5	Very low	Low	Medium	High	Very high
Chorispora tenella	blue mustard	2019	0	2	2	0	0	0	0	2	0	0	0	0
Convolvulus arvensis	field bindweed	2015	4	4	2	2	0	0	0	3	1	0	0	0
		2019	9	9	2	5	2	0	0	4	5	0	0	0
Elymus repens	quackgrass	2019	1	1	1	0	0	0	0	1	0	0	0	0
Malcolmia africana	African mustard	2019	20	20	4	9	6	0	1	12	8	0	0	0
Sisymbrium altissimum	tumble mustard	2019	0	1	1	0	0	0	0	1	0	0	0	0
Tamarix sp.	tamarisk	2012	3	3	2	0	0	1	0	2	0	1	0	0
		2019	10	10	1	2	5	1	1	3	6	1	0	0
Ulmus pumila	Siberian elm	2019	2	2	2	0	0	0	0	2	0	0	0	0
Total IEP priority species		2012	3	3	2	0	0	1	0	2	0	1	0	0
		2015	4	4	2	2	0	0	0	3	1	0	0	0
		2019	42	45	13	16	13	1	2	25	19	1	0	0

[A]Patch size classes: 1 = 1–3 plants (≤2 × 2 m), 2 = 4 plants–40 m^2 (48 yd^2), 3 = 40–400 m^2 (48–478 yd^2), 4= 400–1,000 m^2 (0.1–0.25 acre), 5 = 1,000–2,000 m^2 (0.25–0.5 acre).
[B]Patch size class × Patch density. 1–5 = very low, 6–10 = low, 11–15 = moderate, 16–20 = high, 21–25 = very high.

Table 3-4. Number of priority patches by species, patch size class, and patch management index detected along Cathedral Valley Road in Capitol Reef NP, 2012, 2015, and 2019.

Scientific name	Common name	Year	Patch type		Patch size class[A]					Patch management index[B]				
			Priority	Total	1	2	3	4	5	Very low	Low	Medium	High	Very high
Elaeagnus angustifolia	Russian olive	2019	3	3	3	0	0	0	0	3	0	0	0	0
Malcolmia africana	African mustard	2019	12	12	4	7	1	0	0	10	2	0	0	0
Tamarix sp.	tamarisk	2012	23	23	7	0	8	8	0	7	8	8	0	0
		2015	20	20	0	0	3	1	16	4	16	0	0	0
		2019	62	62	3	2	1	2	54	6	49	7	0	0
Total IEP priority species		2012	23	23	7	0	8	8	0	7	8	8	0	0
		2015	20	20	0	0	3	1	16	4	16	0	0	0
		2019	77	77	10	9	2	2	54	19	51	7	0	0

[A]Patch size classes: 1 = 1–3 plants (≤2 × 2 m), 2 = 4 plants–40 m^2 (48 yd^2), 3 = 40–400 m^2 (48–478 yd^2), 4= 400–1,000 m^2 (0.1–0.25 acre), 5 = 1,000–2,000 m^2 (0.25–0.5 acre).
[B]Patch size class × Patch density. 1–5 = very low, 6–10 = low, 11–15 = moderate, 16–20 = high, 21–25 = very high.

Russian olive (*Elaeagnus angustifolia*). Together, these four species represented 97.5% of all patches recorded in 2019.

Three tree species were found along the monitoring routes: tamarisk, Russian olive, and Siberian elm (*Ulmus pumila*). Of the 72 tamarisk patches recorded, 59 (81.9%) were seedlings and 13 (18.1%) were saplings. There were two patches of mature Russian olive trees and one patch of saplings. Two patches of Siberian elm seedlings were found (see Appendix A).

IEP priority patches were detected along both routes. Cathedral Valley Road had higher IEP priority patches per kilometer (5.68) than the Scenic Drive (2.05).

3.3 Monitoring transects

A total of 66 transects were sampled along monitoring routes in 2019 (Table 3-5; Appendix B). IEP priority species were found on 25 transects (37.9%). Three IEP species were detected: cheatgrass, Russian thistle, and African mustard. Russian thistle, detected in 33.3% of transects sampled, was by far the most widespread IEP species found (Table 3-5). Russian thistle also had the highest percent cover of any IEP species, averaging 0.2% across all transects in 2019. African mustard and cheatgrass were both present in 3% of plots, with <0.01% mean percent cover.

3.4 Results comparison: 2004–2005, 2012, 2015, and 2019

In 2004 (Scenic Drive) and 2005 (Cathedral Valley), Dewey and Anderson (2005a, b) surveyed the same general areas that the NCPN monitored in 2019. Network staff previously sampled the Scenic Drive and Cathedral Valley Road routes in 2012 and 2015. Although Dewey and Anderson covered a significantly larger area than the NCPN surveyed from 2012 to 2019, and survey methods differed in some respects, general comparisons between the two survey periods are useful, if somewhat problematic.

NCPN sampling methods have been consistent, and were based on the methods used by Dewey and Anderson (2005), but mapping is subjective. For example, one observer may record two small patches, separated by 45 m, as two infestations, while another observer records one large infestation.* Dewey and Anderson were also searching for a smaller list of priority species, so comparisons can only be made between

*The patch separation rule is 50 m, but exact measurements are not made in the field.

Table 3-5. Number of transects in which the five most common IEP species were detected/total transects monitored, mean percent cover, and standard error along common monitoring routes at Capitol Reef NP in 2012, 2015, and 2019.

Scientific name	Common name	Year	Cathedral Valley Drive		Scenic Drive	
			Detected/ Total	Percent cover (SE)	Detected/ Total	Percent cover (SE)
Bromus tectorum[A]	cheatgrass	2012	0/13	0	0/38	0
		2015	0/26	0	4/41	.03 (.02)
		2019	0/26	0	2/40	.011 (.01)
Malcolmia africana	African mustard	2012	0/13	0	0/38	0
		2015	*not on list*	*not on list*	*not on list*	*not on list*
		2019	1/26	<0.01 (<0.01)	1/40	<0.01 (<0.01)
Salsola sp.[A]	Russian thistle	2012	6/13	1.3 (0.8)	0/38	0
		2015	15/26	0.1 (0.03)	8/41	0.1 (0.02)
		2019	21/26	0.4 (0.1)	1/40	<0.01 (<0.01)

[A]Not on priority list, but species was consistently recorded in all transects.

priority species common to all monitoring years. Therefore, although general comparisons and major differences noted between the two survey periods are useful and likely represent biological differences, smaller changes may not reflect actual conditions.

The following is a comparison of results from the three sampling periods, given the caveats described above. Eleven different priority species were detected in at least one of the four sampling periods.

3.4.1 Scenic Drive

The frequency of patches of comparable IEP species along the Scenic Drive increased from 0.2 patches/km in 2012 and 2015 to 1.1 patches/km in 2019 (Perkins and Lenhart 2013; Perkins 2016) (Table 3-6). Tamarisk patches, which had declined for over a decade (from 18 patches in 2005 to 3 in 2012, and 0 in 2015), increased in 2019 (10 patches) (see Table 3-3, Figure 3-5). Field bindweed increased from two patches in 2015 (the first year it was found there) to nine in 2019.

Percent cover of invasives was low for all species in transects. Russian thistle in monitoring transects increased from 0% in 2012 to 20% frequency in 2015, but then decreased to 2.5% frequency in 2019. Russian thistle is an annual with the potential for large fluctuations due to weather conditions.

Quackgrass (*Elymus repens*) and Siberian elm (*Ulmus pumila*) were found along the Scenic Drive for the first time in 2019. Of the 42 patches of IEP species found along the Scenic Drive in 2019, 20 were African mustard. As it was first added to the priority list during this monitoring cycle, this species was likely present but unmapped in previous years.

3.4.2 Cathedral Valley Road

The frequency of patches of comparable IEP species along Cathedral Valley Road increased dramatically from 2012 to 2019, from 1.7 to 4.8 patches/km (see Table 3-6). Tamarisk patches increased from 12 in 2005 to 23 in 2012, and 62 in 2019 (see Table 3-4, Figure 3-6).

In 2012, there were seven patches in the smallest size class (1–a few plants), with the remainder (70%) larger than 40 m^2. In 2015, all 20 patches were larger than 40 m^2 and the number of patches in the largest size class (>1,000 m^2) had increased from 0 to 16 (see Table 3-4). In 2019, the majority of patches (54/62) were in the largest size class (>1,000 m^2).

Russian thistle was present in 46% of transects on Cathedral Valley Road in 2012, increasing to 58% in 2015, and to 81% in 2019 (see Table 3-5). No other species were encountered in the monitoring transects.

Russian olive (*Elaeagnus angustifolia*) was discovered for the first time along Cathedral Valley Road in 2019. African mustard (*Malcolmia africana*) was also a new species found in 2019. However, it was not included on the priority species list in 2015, so it may have been present but not recorded. In 2019, a large portion of the patches were African mustard, so it was likely present along these two routes in prior years.

Table 3-6. Patches per kilometer on routes surveyed for the same priority IEP species in Capitol Reef NP, 2012, 2015, and 2019.

Route	Route type	Patches/km		
		2012	2015	2019[A]
Cathedral Valley Road	Road	1.7	1.5	4.8
Scenic Drive	Road	0.2	0.2	1.1

[A]Excludes African mustard (*Malcolmia africana*) patches, because this species was not included on the IEP priority list in 2015.

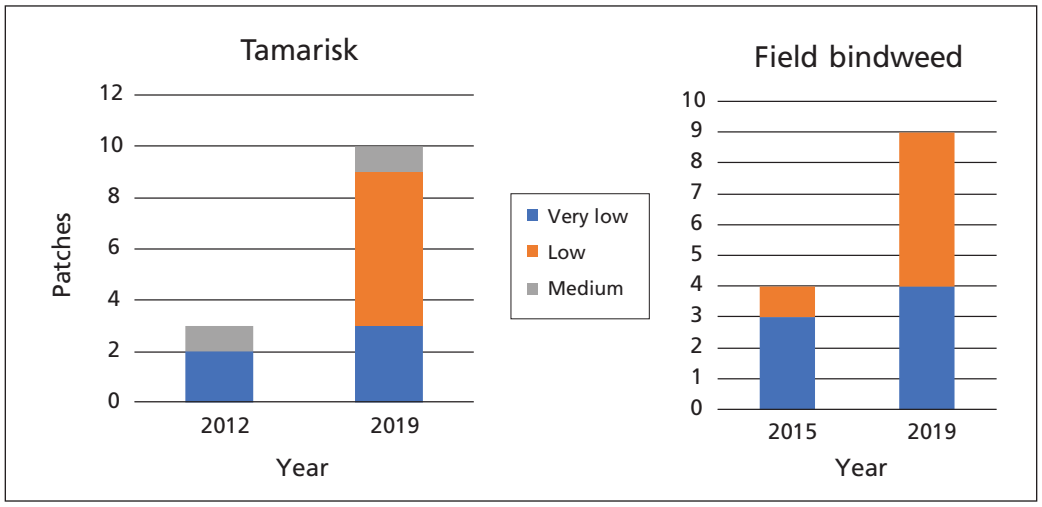


Figure 3-5. Number of patches and patch management index of two common priority IEP species along the Scenic Drive in Capitol Reef National Park.

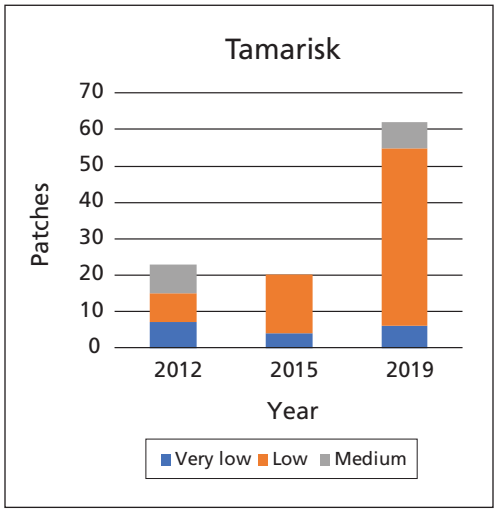


Figure 3-6. Number of patches and patch management index of two common priority IEP species along Cathedral Valley Road in Capitol Reef National Park.

4 Discussion

4.1 Priority IEP list

The NCPN will continue to work with park staff and area IEP 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 area surveyed. However, data for non-priority species should not be assumed to be complete, as these species were not reliably mapped across observers, routes, or years.

During 2019 field monitoring, two non-priority exotic species were observed and occasionally recorded along the Scenic Drive (see Figures 3-1 and 3-2): blue mustard (*Chorispora tenella*) and tumble mustard (*Sisymbrium altissimum*). These species could be considered for inclusion on the IEP priority list for the next monitoring rotation. It is important to bear in mind the overall length of the IEP priority list, as well as potential for control, when adding species. Species may also be considered for monitoring in transects only.

Additional non-priority species observed on monitoring routes included:

- Yellow salsify (*Tragopogon dubius*): occasional and sparse along both the Scenic Drive and Cathedral Valley Road
- Yellow sweet-clover (*Melilotus officinalis*): common along the Scenic Drive and occasional along the Cathedral Valley Road
- Dandelion (*Taraxacum officinale*): infrequent along the Scenic Drive
- Halogeton (*Halogeton glomeratus*): infrequent along the Scenic Drive and Cathedral Valley Road
- Smooth brome (*Bromus inermis*): sparse and patchy along the Scenic Drive

4.2 Possibilities for management control

The patch management index (PMI) was originally intended to elucidate changes in IEP populations over time, but it can also be used to inform treatment decisions. The vast majority of patches in Capitol Reef NP were low or very low on the scale, indicating that most patches are small in area, sparse in cover, or both (see Tables 3-3 and 3-4). However, these patches should not be interpreted as insignificant. On the contrary, they may be some of the most important areas to treat, especially for isolated and/or uncommon species, such as Russian olive. Prioritizing treatment of small-scale patches can effectively prevent future spread and possibly eradicate the infestations. Managers should consider species traits (e.g., how likely and quickly plants may spread) and environmental conditions (precipitation and temperature), and combine this information with patch number and PMI values when determining treatment priorities.

Tamarisk was the most prevalent priority IEP along the monitored routes. The 72 patches recorded (see Tables 3-3 and 3-4) represent a marked increase from previous monitoring years. Not only were many more tamarisk patches recorded, but the size of the patches also dramatically increased, with most being in the largest size class. This indicates that previously identified infestations have expanded and grown. Most (55 of 72) infestations scored low on the patch management index, with the remainder being very low or medium. As they are sparsely scattered across a broad landscape, controlling these populations will mean travel across large areas. We recommend that the Scenic Drive and Cathedral Valley Road be prioritized for exotic species control to help prevent further increases in the size and number of patches.

The next most-common priority species were African mustard (*Malcolmia africana*, 32 patches), field bindweed (*Convolvulus arvensis*, 9 patches), and Russian olive (*Elaeagnus angustifolia*, 3 patches). These three species had PMI scores of low or very low, indicating that infestations are small and/or sparse, though widespread. Quackgrass (*Elymus repens*) and Siberian elm (*Ulmus pumila*) were found in just one and two patches, respectively. We recommend immediate control of these species, as they were found infrequently enough for control

to be possible and these species can quickly expand if not treated.

In transects, Russian thistle (*Salsola* sp.) was by far the most widespread species. The proportion of transects that contained Russian thistle declined along the Scenic Drive but increased along Cathedral Valley Road compared to 2015 (Perkins 2016). The percent cover of Russian thistle on both routes was only 0.16%.

It should be noted that overall IEP percent cover was very low, and the two monitoring routes had relatively few priority invasive plants. Efforts should be made to make these areas IEP-free.

Estimates of percent cover in this report (see Table 3-5) 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 Capitol Reef NP will generally be monitored at the same time each 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 drastically alter the chances of detecting invasive species at a level larger than the minimum detection target size.

The NCPN plans to return to Capitol Reef in 2020 to monitor Oak and Pleasant creeks, completing the third rotation of invasive plant monitoring. Because any previous detections could have been eradicated by park staff, the locations of monitoring transects are re-generated each year. 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.

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Appendix A. Location of Invasive Exotic Plant Patches on Monitoring Routes

Invasive exotic plant patches detected on the Scenic Drive, Capitol Reef NP, May 30–June 1, 2019.

Species	Common name	Pulled?	Growth stage	N_Coord	E_Coord	Cover class	Size class
Chorispora tenella	Blue mustard	1	–	4231540.935	480451.363	5	1
Chorispora tenella	Blue mustard	0	–	4235624.589	478512.882	3	1
Convolvulus arvensis	Field bindweed	0	–	4231535.255	480445.878	3	2
Convolvulus arvensis	Field bindweed	1	–	4229344.471	481855.82	3	2
Convolvulus arvensis	Field bindweed	1	–	4229889.204	481318.922	3	1
Convolvulus arvensis	Field bindweed	0	–	4231937.37	480414.425	2	2
Convolvulus arvensis	Field bindweed	1	–	4229094.603	482453.861	4	2
Convolvulus arvensis	Field bindweed	1	–	4228948.1	482710.618	2	2
Convolvulus arvensis	Field bindweed	0	–	4229440.865	481627.271	3	1
Convolvulus arvensis	Field bindweed	0	–	4235500.293	478546.049	3	3
Convolvulus arvensis	Field bindweed	0	–	4235549.78	478523.873	3	3
Elymus repens	Quackgrass	0	–	4236697.892	478177.887	3	1
Malcolmia africana	African mustard	0	–	4230736.638	480696.528	2	3
Malcolmia africana	African mustard	0	–	4232760.1	480210.83	1	2
Malcolmia africana	African mustard	0	–	4232369.06	480370.669	2	2
Malcolmia africana	African mustard	0	–	4229307.314	481948.634	3	2
Malcolmia africana	African mustard	0	–	4229131.041	482361.762	1	2
Malcolmia africana	African mustard	0	–	4229253.694	482034.461	2	2
Malcolmia africana	African mustard	0	–	4232506.741	480367.619	4	1
Malcolmia africana	African mustard	0	–	4231873.311	480440.785	3	2
Malcolmia africana	African mustard	0	–	4234292.31	479617.612	1	3
Malcolmia africana	African mustard	1	–	4229773.219	481395.411	5	1
Malcolmia africana	African mustard	1	–	4229342.826	481813.19	4	1
Malcolmia africana	African mustard	1	–	4233941.9	479736.867	2	2
Malcolmia africana	African mustard	0	–	4229304.22	481961.074	1	3
Malcolmia africana	African mustard	0	–	4232736.975	480215.705	3	3
Malcolmia africana	African mustard	0	–	4230589.88	480799.01	2	3
Malcolmia africana	African mustard	0	–	4230692.297	480737.159	1	5
Malcolmia africana	African mustard	0	–	4232445.035	480368.048	3	2
Malcolmia africana	African mustard	0	–	4234963.211	478873.852	5	1
Malcolmia africana	African mustard	0	–	4232642.025	480281.964	2	3

Invasive exotic plant patches detected on the Scenic Drive, Capitol Reef NP, May 30–June 1, 2019 (continued).

Species	Common name	Pulled?	Growth stage	N_Coord	E_Coord	Cover class	Size class
Malcolmia africana	African mustard	1	–	4230410.092	480899.589	3	2
Sisymbrium altissimum	tumble mustard	1	–	4228947.322	482983.096	5	1
Tamarix sp.	tamarisk	0	Sapling(s)	4229066.458	482498.448	2	3
Tamarix sp.	tamarisk	0	Sapling(s)	4229017.2	482509.863	2	3
Tamarix sp.	tamarisk	0	Sapling(s)	4228959.851	482737.721	3	4
Tamarix sp.	tamarisk	1	Sapling(s)	4228884.316	482613.319	3	2
Tamarix sp.	tamarisk	0	Sapling(s)	4228915.79	482786.367	2	5
Tamarix sp.	tamarisk	0	Sapling(s)	4228965.907	482509.654	1	2
Tamarix sp.	tamarisk	0	Sapling(s)	4228913.618	482521.005	1	3
Tamarix sp.	tamarisk	0	Sapling(s)	4229098.144	482459.651	2	3
Tamarix sp.	tamarisk	0	Sapling(s)	4229138.47	482377.026	3	3
Tamarix sp.	tamarisk	0	Sapling(s)	4233240.599	480044.407	3	1
Ulmus pumila	Siberian elm	1	Seedling(s)	4231252.679	480556.829	4	1
Ulmus pumila	Siberian elm	0	Seedling(s)	4232938.739	480185.756	5	1

Invasive exotic plant patches detected on Cathedral Valley Road, Capitol Reef NP, May 30–June 1, 2019.

Species	Common name	Pulled?	Growth stage	N_Coord	E_Coord	Cover class	Size class
Elaeagnus angustifolia	Russian-olive	0	Sapling(s)	4261003.772	476759.047	5	1
Elaeagnus angustifolia	Russian-olive	0	Mature Tree(s)	4261204.209	475735.693	5	1
Elaeagnus angustifolia	Russian-olive	0	Mature Tree(s)	4261008.636	476760.748	5	1
Malcolmia africana	African mustard	1	–	4261105.482	475846.387	5	1
Malcolmia africana	African mustard	0	–	4261985.829	473615.177	1	2
Malcolmia africana	African mustard	0	–	4262131.06	473098.479	3	2
Malcolmia africana	African mustard	0	–	4262128.326	473176.114	1	2
Malcolmia africana	African mustard	1	–	4262052.178	472617.087	5	1
Malcolmia africana	African mustard	1	–	4262121.002	473193.742	3	3
Malcolmia africana	African mustard	0	–	4262058.263	473390.992	1	2
Malcolmia africana	African mustard	0	–	4262095.739	473362.458	5	1
Malcolmia africana	African mustard	0	–	4262034.24	473390.606	1	2
Malcolmia africana	African mustard	0	–	4262126.424	473153.701	2	2
Malcolmia africana	African mustard	0	–	4262138.849	473123.446	1	2
Malcolmia africana	African mustard	1	–	4261135.787	475800.402	5	1
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261760.489	474750.436	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261100.095	476404.106	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261367.748	475610.753	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4260974.664	476065.477	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261025.619	476152.733	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261060.66	475982.097	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261210.23	477380.077	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4260989.98	476043.383	1	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261216.025	477277.735	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261062.894	476203.089	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4260975.045	476124.096	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261320.922	478019.413	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261165.171	477638.639	3	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261098.297	476561.047	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261092.514	476254.984	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261390.923	475559.427	3	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261156.917	477570.228	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261242.336	477722.382	3	5

Invasive exotic plant patches detected on Cathedral Valley Road, Capitol Reef NP, May 30–June 1, 2019 (continued).

Species	Common name	Pulled?	Growth stage	N_Coord	E_Coord	Cover class	Size class
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261205.264	477430.727	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261212.004	477098.262	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261649.868	474913.286	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261217.847	477164.192	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261122.599	476670.886	2	5
Tamarix sp.	tamarisk	0	Sapling(s)	4261173.001	477553.416	1	2
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261274.038	478171.855	3	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261182.366	477664.625	4	3
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261193.118	476951.947	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261105.256	475847.891	5	1
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261213.719	477326.805	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261415.218	475396.291	3	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261133.239	475813.729	5	2
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261406.992	475506.109	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261102.72	476455.315	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261218.68	475719.424	2	4
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261199.649	477000.552	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261836.56	474006.798	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261205.489	477048.974	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261099.672	476342.305	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261778.139	474586.945	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261417.765	475453.58	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261009.017	476015.538	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261671.175	474864.422	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261093.108	476507.945	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261065.723	475979.134	5	1
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261386.035	475562.75	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261324.614	475642.902	5	1
Tamarix sp.	tamarisk	0	Sapling(s)	4261418.555	475422.639	1	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261564.195	475085.303	2	4
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261760.791	474525.876	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261216.555	477224.612	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261416.779	475327.044	2	5

Invasive exotic plant patches detected on Cathedral Valley Road, Capitol Reef NP, May 30–June 1, 2019 (continued).

Species	Common name	Pulled?	Growth stage	N_Coord	E_Coord	Cover class	Size class
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261318.342	477847.891	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261974.94	473460.055	2	5
Tamarix sp.	tamarisk	0	Sapling(s)	4261382.117	475586.128	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261268.133	478259.448	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261182.804	476899.151	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261409.596	475342.178	3	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261784.892	474043.376	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261193.972	477501.262	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261111.422	476615.075	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261404.52	475375.816	2	5
Tamarix sp.	tamarisk	0	Mature Tree(s)	4261581.153	475040.252	2	5

Appendix B. Location of Invasive Exotic Plant Patches in Transects

Invasive exotic plant patches detected in transects on the Scenic Drive, Capitol Reef NP, May 30–June 1, 2019.

Species	Common name	Transect	E_Coord	N_Coord	Alive?	Average cover
Bromus tectorum	Cheatgrass	847	479920.291	4233476.195	Y	0.167
Salsola sp.	Russian thistle	858	481548.395	4229561.426	Y	0.167
Malcolmia africana	African mustard	861	480698.085	4230747.298	Y	0.167
Bromus tectorum	Cheatgrass	871	478831.643	4235001.27	Y	0.333

Invasive exotic plant patches detected in transects on Cathedral Valley Road, Capitol Reef NP, May 30–June 1, 2019.

Species	Common name	Transect	E_Coord	N_Coord	Alive?	Average cover
Salsola sp.	Russian thistle	875	472759.268	4262025.306	Y	0.167
Salsola sp.	Russian thistle	876	473221.655	4262122.863	Y	0.667
Malcolmia africana	African mustard	877	473641.641	4261979.732	Y	0.167
Salsola sp.	Russian thistle	877	473641.641	4261979.732	Y	0.833
Salsola sp.	Russian thistle	878	474071.602	4261763.672	Y	0.333
Salsola sp.	Russian thistle	880	474988.618	4261618.782	Y	1.167
Salsola sp.	Russian thistle	881	475421.997	4261420.416	Y	0.167
Salsola sp.	Russian thistle	882	475802.791	4261139.264	Y	0.833
Salsola sp.	Russian thistle	883	476195.348	4261059.727	Y	0.333
Salsola sp.	Russian thistle	884	476684.077	4261130.692	Y	0.5
Salsola sp.	Russian thistle	885	477175.475	4261223.568	Y	0.833
Salsola sp.	Russian thistle	886	477641.086	4261167.06	Y	0.667
Salsola sp.	Russian thistle	887	478085.306	4261297.095	Y	0.5
Salsola sp.	Russian thistle	888	472757.783	4262024.085	Y	0.167
Salsola sp.	Russian thistle	889	473222.687	4262118.838	Y	0.333
Salsola sp.	Russian thistle	892	474543.675	4261768.111	Y	0.25
Salsola sp.	Russian thistle	893	474989.519	4261613.468	Y	0.667
Salsola sp.	Russian thistle	894	475422.736	4261416.511	Y	0.167
Salsola sp.	Russian thistle	896	476194.622	4261059.043	Y	0.333
Salsola sp.	Russian thistle	897	476684.422	4261126.268	Y	0.667
Salsola sp.	Russian thistle	898	477174.354	4261218.709	Y	0.167
Salsola sp.	Russian thistle	900	478091.759	4261296.254	Y	0.667

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NPS 158/176577, June 2021

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U.S. Department of the Interior

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