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Natural Resource Stewardship and Science

Invasive Exotic Plant Monitoring along Pleasant Creek in Capitol Reef National Park

Field Season 2014

Natural Resource Report NPS/NCPN/NRR—2015/940



ON THE COVER

Tamarisk (*Tamarisk* spp.). Tom Heutte, USDA Forest Service, Bugwood.org.

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Abstract

Invasive exotic plant (IEP) species are a significant threat to natural ecosystem integrity and biodiversity, and controlling IEPs 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. In conjunction with park staff, NCPN created a target list of priority IEPs for early detection. During surveys conducted on October 2–6, 2014, Capitol Reef National Park staff detected two priority IEP species on monitoring routes and three IEP species (one priority) in transects along 10.2 kilometers of Pleasant Creek. Tamarisk (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*) (49 and 8 patches, respectively) were the priority IEPs detected along monitoring routes. Russian thistle (*Salsola tragus*) was the most widespread IEP species on transects (present on 21%), and had the highest average percent cover, of 1.95%. Tamarisk and cheatgrass (*Bromus tectorum*) were also detected on transects. IEPs were present in 26% of the 19 transects sampled, with a total cover of 4.6%. Percent cover of all three species and all IEP species combined was similar between 2010 and 2014. The number of tamarisk patches mapped along monitoring routes in 2014 declined from 2010. However, that decline in number may not represent a decrease in area, as the number of patches larger than 40 m^2 increased substantially and patches smaller than a few plants decreased. This increase could indicate that smaller patches joined together into large patches. In addition, 63% of the patches were classified as mature trees. This indicates that Pleasant Creek should be a target of exotic plant control before IEPs become widespread.

Acknowledgements

A. Wight was extremely helpful in generating routes, transects, and other GIS information. G. Lenhart conducted the field work. T. Fisk and S. Borthwick assisted with reviewing the park's target invasive plant list, arranging site logistics, and providing land-use history of the site. D. Thoma, T. Fisk, and S. Borthwick improved this report with their thoughtful review. Data management was provided by H. Thomas. D. Perry 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 target IEPs in parks along key invasive pathways.

Invasive exotic plants can spread into national parks via a number of 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 escapees, livestock grazing and trailing, and seeds transported on apparel 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; and
2. To determine status and trends of selected invasive plant populations of management significance.

This report summarizes the 2014 field season along Pleasant Creek at Capitol Reef National Park (NP).

2 Methods

We followed the invasive exotic plant monitoring protocol developed by the NCPN (Perkins et al. 2013). The protocol emphasizes the quick collection of IEP location and abundance data in order to maximize the amount of area searched, thus increasing our chances 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 will 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 2014, NCPN and Capitol Reef NP staff reviewed the park's list of high-priority target IEPs (Table 2-1), initially created in 2009. 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 are designed to be rapid, field crews are 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 species is reviewed before each field season with a few minor changes from year to year.

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 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 plants of some species, such as Russian olive (*Elaeagnus angustifolia*) and tamarisk (*Tamarix* spp.), 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

Table 2-1. Priority invasive plant list, Capitol Reef NP, 2009–2014.

Scientific name	Common name
Ailanthus altissima	tree-of-heaven
Arctium minus	burdock
Asparagus officinalis	asparagus
Cardaria draba	hoary cress
Carduus nutans	musk thistle
Centaurea diffusa	diffuse knapweed
Centaurea maculosa	spotted knapweed
Centaurea repens	Russian knapweed
Cirsium arvense	Canada thistle
Cirsium vulgare	bull thistle
Convolvulus arvensis	field bindweed
Cynoglossum officinale[1]	common hounds-tongue
Elaeagnus angustifolia	Russian olive
Elymus repens	quackgrass
Euphorbia esula	leafy spurge
Hyoscyamus niger[1]	black henbane
Isatis tinctoria	Dyer's woad
Lythrum salicaria	purple loosestrife
Marrubium vulgare	horehound
Onopordum acanthium	Scotch thistle
Tamarix spp.	tamarisk
Ulmus pumila	Siberian elm
Verbascum thapsus	woolly mullein
Carduus acanthoides[2]	plumeless thistle
Malcolmia africana[3]	African mustard
Medicago sativa[4]	alfalfa

[1]Added in 2012
[2]2009–2011 only
[3]2012–2013 only
[4]2009–2010 only

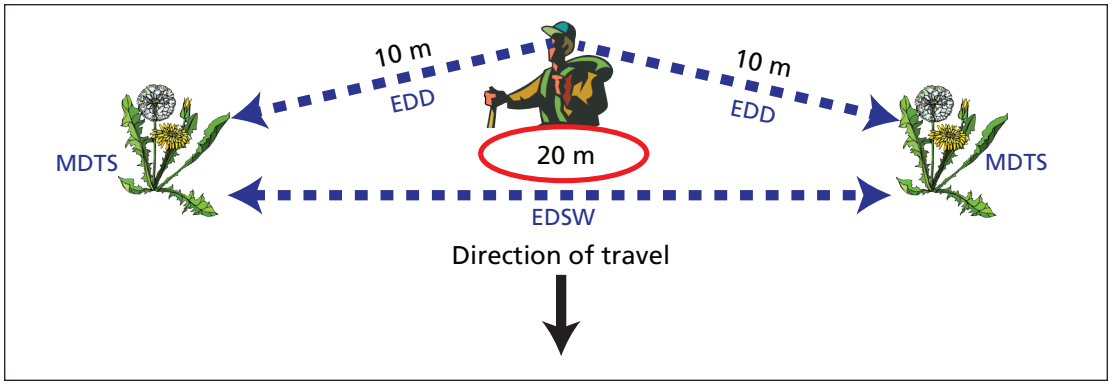


Figure 2-1. The maximum effective detection distance (EDD) at Capitol Reef National Park was 10 meters, making the effective detection swath width (EDSW) 20 meters.

(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 2014 was 10 m.

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 to effectively detect IEPs for one EDD on either side of his/her search route. The EDSW was 20 m at Capitol Reef NP in 2014.

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. 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 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 Between feature position

Between feature positions allow electronic tracking of a user's route. A GPS 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 trails, Oak Creek cattle trails, and Cathedral monitoring route (Table 2-2, Figure 2-2). In 2014, Pleasant Creek was visited for the second time.

Table 2-2. Planned monitoring revisit design for invasive plant monitoring at Capitol Reef National Park.

Year	Monitoring routes
2009	Highway 24/Fremont Corridor
2010	**Pleasant Creek**
2011	Oak Creek
2012	Cathedral
2013	Highway 24/Fremont Corridor
2014	**Pleasant Creek**
2015	Oak Creek
2016	Cathedral
2017	Highway 24/Fremont Corridor
2018	**Pleasant Creek**
2019	Oak Creek
2020	Cathedral

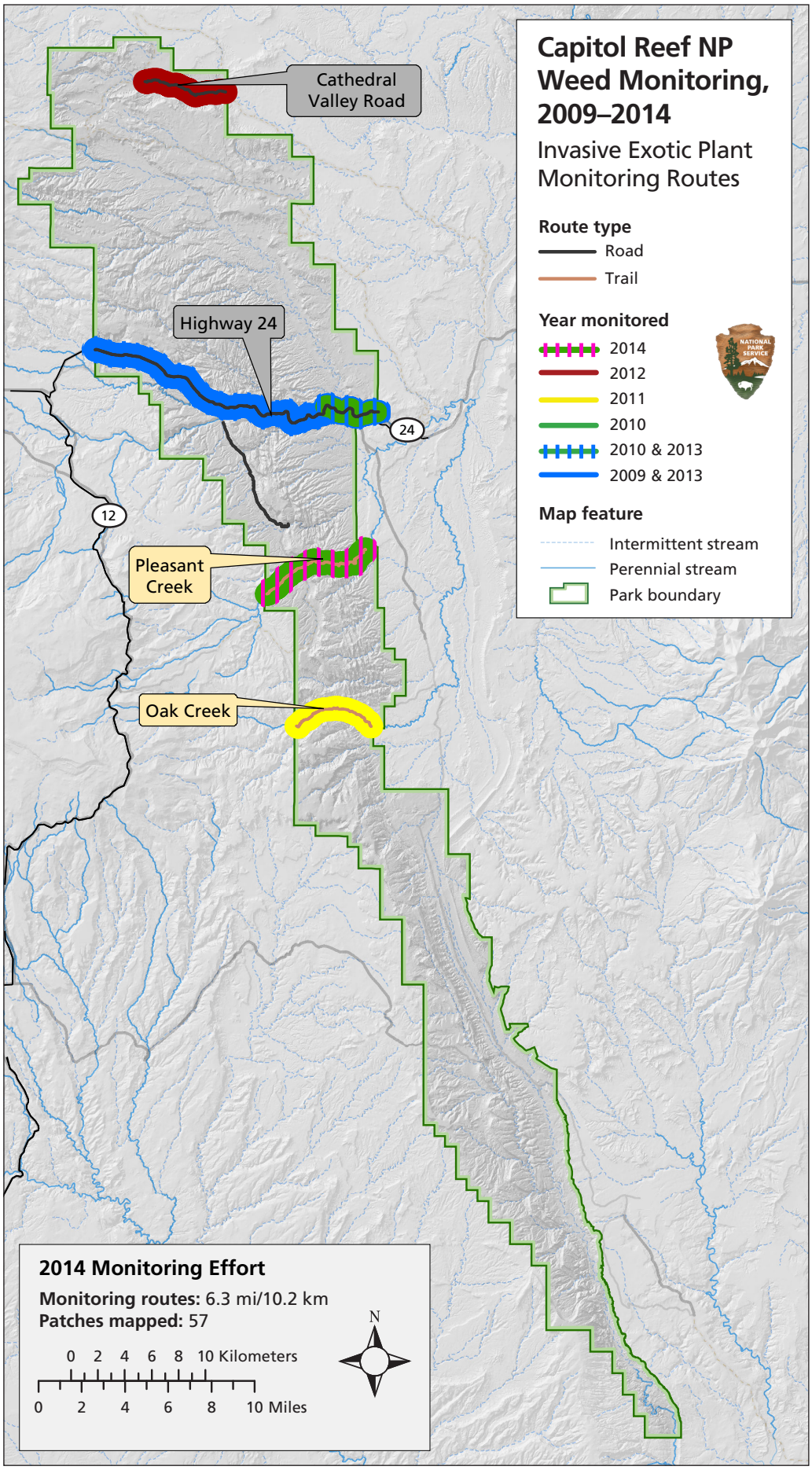


Figure 2-2. Overview of invasive exotic plant monitoring routes and extra areas surveyed at Capitol Reef National Park, 2009–2014.

Along Highway 24, the observer walks out on one side of the road and walks back on the other. For all other routes, the observer walks down the center of the trail/route. While surveying Pleasant Creek, 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 20 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 five-meter accuracy.

Only IEPs that were designated as priority were consistently recorded on monitoring routes. Survey crew members were given the latitude 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 by the observer, and (5) canopy cover class (see below). If several IEPs 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. Patch size class was estimated as follows:

1. 1–a few plants (used for isolated single plants or very small patches (≤ 2 × 2 m),
2. few 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), 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).

2.3 Monitoring transects

2.3.1 Quadrat establishment

We established one transect with three vegetation quadrats every 500 m along monitoring routes (see Figure 2-3). We centered vegetation quadrats at 0.5, 5, and 10 m away from the edge of a road on the same side as the route being walked and on alternating sides for riparian areas, small roads, or trails.* 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 walked the monitoring route. In some cases, we leveled the sampling frame by propping up quadrat corners.

2.3.2 Data collection methods

In the monitoring quadrats, all IEP species known to the observer were recorded. At minimum, this included all priority species, as well as cheatgrass (*Bromus tectorum*), crested wheatgrass (*Agropyron cristatum*), and Russian thistle (*Salsola tragus*). 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 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).

*In 2009, quadrats were placed at 1, 6, and 11 m away from the monitoring route.

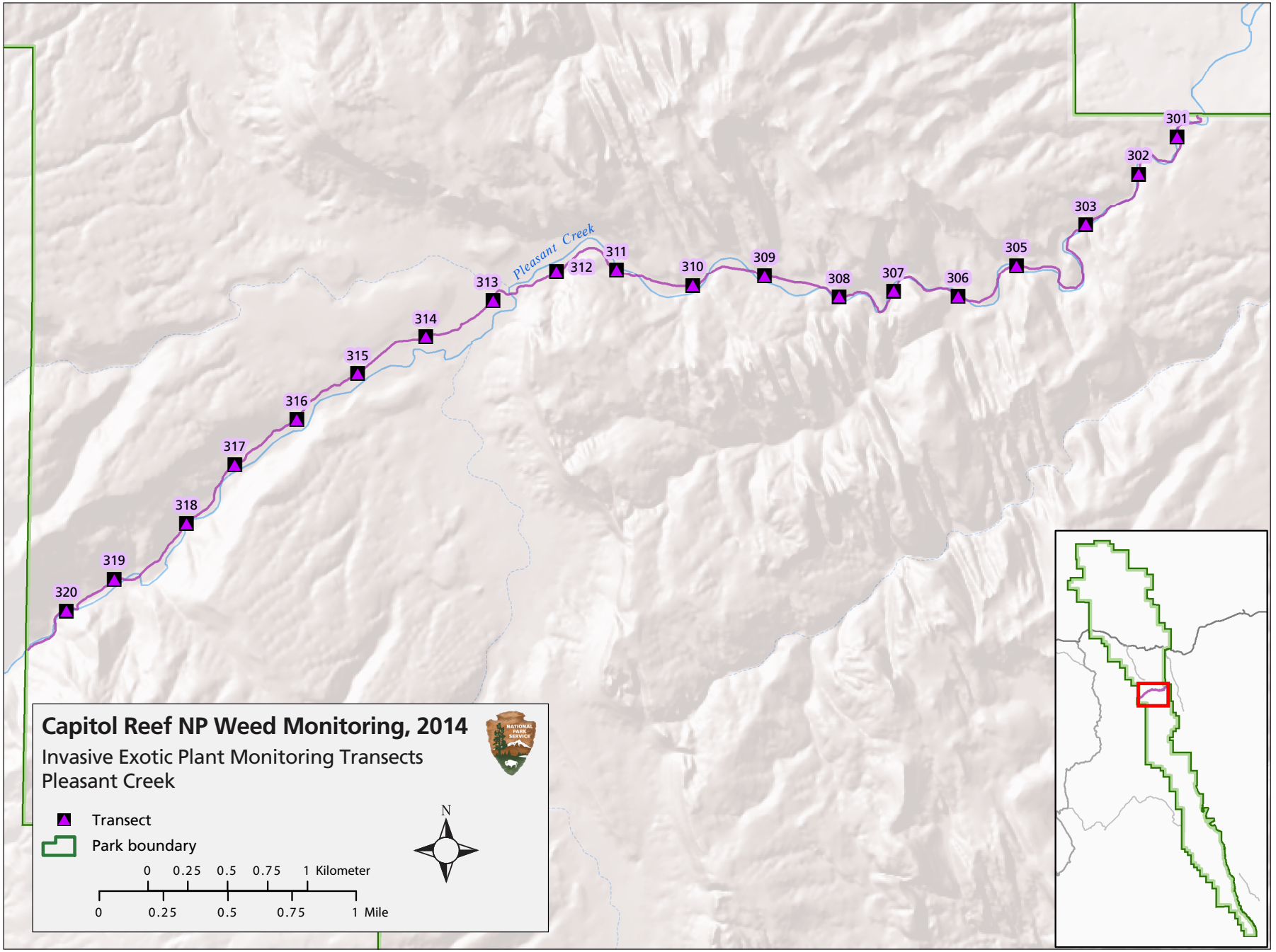


Figure 2-3. Monitoring transects along Pleasant Creek, Capitol Reef National Park, October 2–6, 2014.

2.4 Analyses

We calculated the mean number of patches 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. Due to differences in observers' knowledge, only priority species should be used when comparing results from year to year.

3 Results

3.1 Target invasive exotic plant list

In 2014, field crews searched on monitoring routes for 23 species identified as high-priority at Capitol Reef NP (see Table 2-1). 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 absence data for other species are suspect.

We recorded a total of four IEP species on monitoring routes and transects in 2014 (Table 3-1). Tamarisk and Russian olive, both priority species, were recorded on monitoring routes. Tamarisk, cheatgrass, and Russian thistle were recorded on monitoring transects. We covered 10.2 km (6.3 miles) of monitoring routes in 2014.

3.2 Monitoring routes

We surveyed the entire Pleasant Creek corridor within the park in 2014. A total of 57 patches of two different priority species were detected along the monitoring routes (Table 3-2; Figures 3-1, 3-2; Electronic Appendix A). We recorded patches of tamarisk (49) and Russian olive (8). This resulted in 4.8 tamarisk and 0.1 Russian olive patches per km along Pleasant Creek. Of the 57 tree patches, 0 were in the seedling stage, 21 were in the sapling stage, and 36 were mature trees (see Electronic Appendix A). The eastern portion of Pleasant Creek, where the canyon is wider, had more patches than the western portion (see Figures 3-2, 3-3).

3.3 Monitoring transects

A total of 19 transects were sampled in 2014 (Table 3-3; Electronic Appendix B). Tamarisk, Russian thistle, and cheatgrass were detected. IEPs were found on 26% of transects, with an average of 0.37 IEP species detected per plot. Percent cover of these invasives along Pleasant Creek was 4.57%. Russian thistle was the most widespread IEP species, present on 21% of transects, and had the highest average percent cover, of 1.95%.

3.4 Results comparison: 2003, 2010, and 2014

In 2003, Dewey and Anderson (2005) surveyed the same sections of Pleasant Creek that the NCPN surveyed in 2010 and 2014. Although the area covered along Pleasant Creek in 2003 was significantly larger than the area covered in 2010 and 2014, and survey methods differed in some respects, general comparisons between the two survey periods are useful (if somewhat problematic).

Tamarisk, Russian olive, and tree-of-heaven (*Ailanthus altissima*) (target species in 2003 and priority species in 2010 and 2014) were all detected in at least one of the three time periods. One tree-of-heaven patch was detected in 2003, but this species was not detected in 2010 or 2014. Russian olive has been detected in a few patches in each year: four in 2003, three in 2010, and eight in 2014. The number of tamarisk patches has declined over time, from 100 patches detected in 2003, to 60 in 2010, and 49 in 2014.

Methods were the same between 2010 and 2014, so these numbers are directly comparable (Table 3-2). While there were fewer patches of tamarisk in 2014 than 2010, the number of tamarisk patches larger than 40 m^2 increased from 5 to 24, while patches smaller than a few plants decreased from 41 to 11. There were minimal changes in (a) percent cover of the three species detected and (b) total cover of invasive species from 2010 to 2014 (Table 3-3).

Table 3-1. Invasive exotic plants detected along Pleasant Creek at Capitol Reef National Park, 2014.

Scientific name	Common name	Method detected		Park priority?
		Route	Transect	
Elaeagnus angustifolia	Russian olive	X		Yes
Tamarix spp.	tamarisk	X	X	Yes
Bromus tectorum	cheatgrass		X	No
Salsola tragus	Russian thistle		X	No

Bold type indicates those species found in the 2014 monitoring efforts.

Table 3-2. Number of patches by species and size class detected along the Pleasant Creek monitoring route, Capitol Reef NP, 2010 and 2014.

Scientific name	Common name	Year	Total patches	Patch size class				
				1	2	3	4	5
Elaeagnus angustifolia	Russian olive	2010	3	2	1	0	0	0
		2014	8	6	2	0	0	0
Tamarix spp.	tamarisk	2010	60	41	14	5	0	0
		2014	49	11	13	24	1	0
Total patches		2010	63	43	15	5	0	0
		2014	57	17	15	24	1	0

Table 3-3. Number of monitoring transects where exotic plant species were detected/ total transects monitored, mean percent cover, and standard error by sampling area along Pleasant Creek at Capitol Reef NP, 2010 and 2014.

Scientific name	Common name	2010		2014	
		Detected (of 20)	Percent cover (SE)	Detected (of 19)†	Percent cover (SE)
*Bromus tectorum**	cheatgrass	0	0.00 (0.00)	2	1.23 (0.85)
*Salsola tragus**	Russian thistle	6	5.13 (3.00)	4	1.95 (1.75)
Tamarisk spp.	tamarisk	1	0.67 (0.67)	1	1.40 (1.40)
All invasive species		7	5.80 (3.02)	5	4.58 (2.24)

*Not on priority list, but a species that is consistently looked for and recorded, if present, in all transects.
†Although the route is the same in all years this route is surveyed, the number of transects may vary.

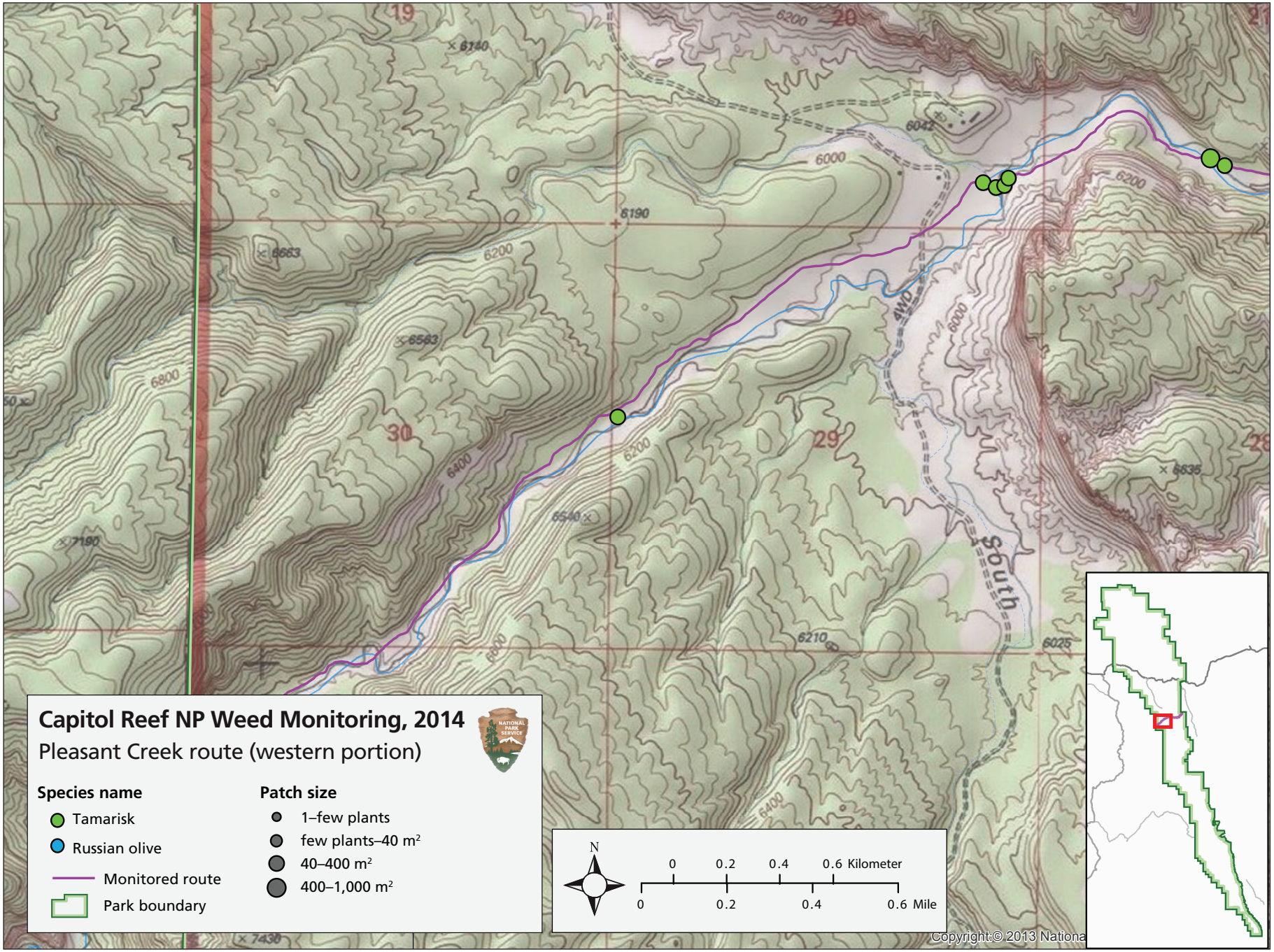


Figure 3-1. Priority invasive exotic plants detected on the western portion of Pleasant Creek, Capitol Reef National Park, October 2–6, 2014.

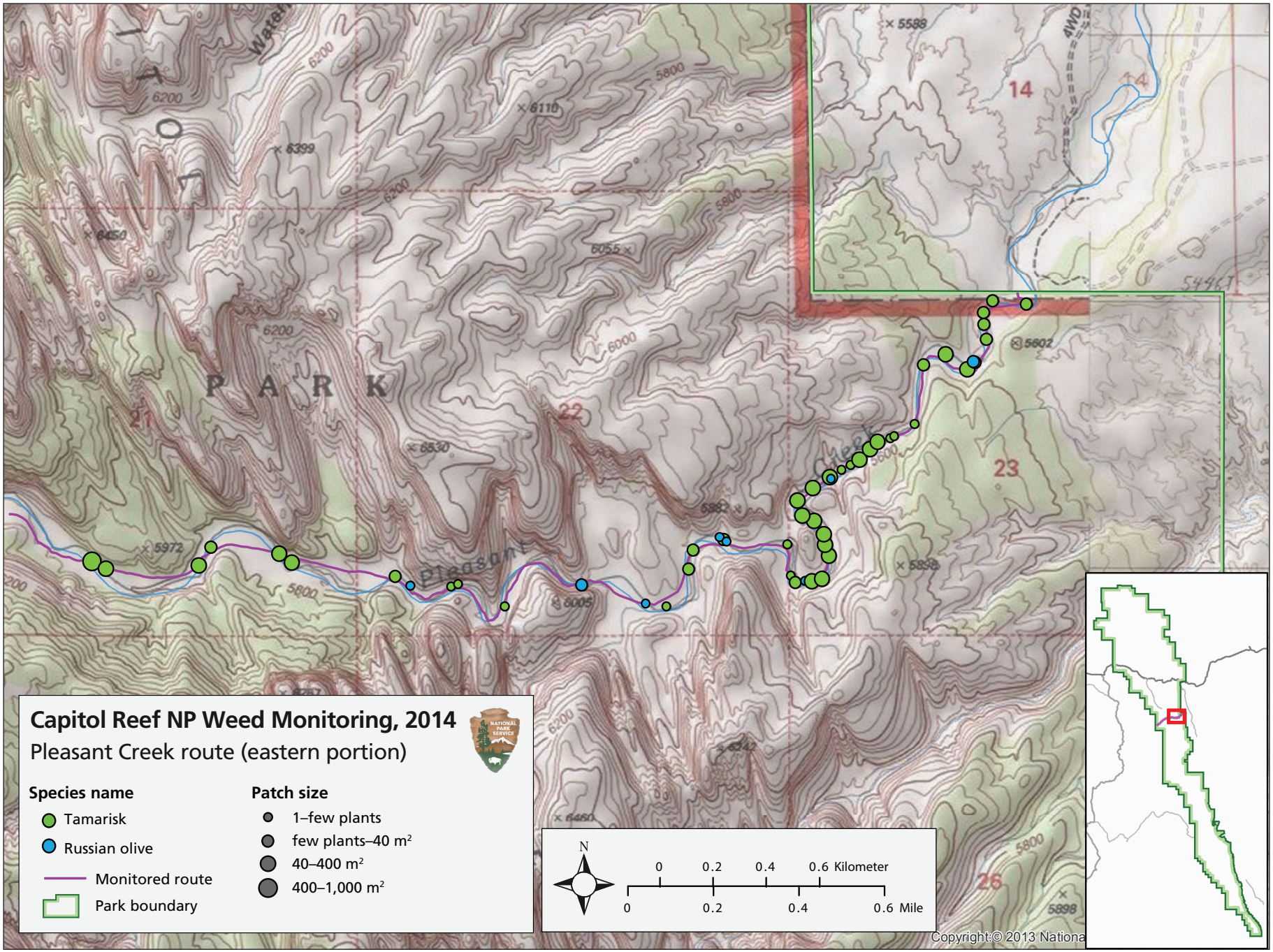


Figure 3-2. Priority invasive exotic plants detected on the eastern portion of Pleasant Creek, Capitol Reef National Park, October 2–6, 2014.

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, and presence data for other species, should be reliable for the area surveyed. However, absence data for non-priority species are suspect, because not all observers recorded all of these species in all years. African mustard (*Malcolmia africana*) was removed from the priority list in 2014, because it is widespread and likely beyond management control. No changes to the list are currently recommended.

4.2 Possibilities for management control

The park has targeted tree-of-heaven and spotted knapweed for control efforts since the inventories in 2003–2005. Both species remain absent from Pleasant Creek. While there were relatively few IEP species detected in Pleasant Creek, the increase in the number of large tamarisk patches is concerning. There were fewer overall patches detected, but the number of tamarisk patches smaller than a few plants decreased, while the number of larger patches increased. This indicates that smaller patches have combined into larger patches, which are more difficult to control. Eight Russian olive patches were detected (up from three in 2010); control should take place before they become more widespread. Russian olive patches were present in more western locations in 2014 than in 2010. It is encouraging that the more widespread species, such as cheatgrass and Russian thistle, have remained at relatively low percent covers in Pleasant Creek.

There was no control work performed on tamarisk in Pleasant Creek between 2010 and 2014. The overall distribution of tamarisk has not changed between the two time periods, with higher patch densities in the eastern portion of Pleasant Creek. The lower prevalence of tamarisk in the western sections could be due to the narrower confines of Pleasant Creek canyon, where more forceful flood currents may have decreased the ability of tamarisk to become well-established. The lower detection rate also could be an artifact of the sampling route. In the western portion of Pleasant Creek, the route follows old roads and trails on upland benches not located in tamarisk habitat. In the eastern portion, the route more closely follows the riparian area, which is more suitable for tamarisk.

Park staff is hoping that defoliation by the tamarisk beetle (*Diorhabda carinulata*) will make future control efforts easier. The tamarisk beetle's presence was confirmed for the first time along the Fremont River in 2010 (G. Lenhart, pers. comm.). However, the beetle had not been detected in the Pleasant Creek corridor as of the end of the 2014 field season (T. Fisk, pers. comm.). Continued monitoring will show the effects of both future control efforts and the tamarisk beetle as a biological control agent. Mortality of tamarisk from the beetle has required several years of defoliation at Dinosaur National Monument (NM); however, stem mortality can allow native species to colonize and compete with tamarisk stands (Williams 2013). Stem mortality at Dinosaur NM increased substantially in 2013, seven years after the first releases of tamarisk beetle.

It should be noted that estimates of percent cover in this report (see Table 3-3) 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. In 2015, the NCPN will revisit the Oak Creek monitoring route. We may also complete some extra-area surveys in locations yet to be determined. Because any previous detections could have been eradicated by park staff, the locations of monitoring quadrats 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.

5 Literature Cited

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Appendix A. Exotic plant patches detected on monitoring routes at Capitol Reef NP, October 2–6, 2014.

See electronic appendices.

Appendix B. Exotic plant transect data detected at Capitol Reef NP, October 2–6, 2014.

See electronic appendices.

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

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