



Fort Larned National Historic Site Invasive Plant Monitoring Summary—2025

Summary

In July 2025, the Southern Plains Inventory & Monitoring Network (SOPN) completed an invasive plant grid-point survey of Fort Larned National Historic Site (FOLS). Grid-point surveys are an element of our Exotic Plant–Early Detection Protocol and provide data on the extent and distribution of invasive plants within the park interior landscape. At each grid point, we surveyed a 10-m-radius circle for 15 high-priority invasive plants and estimated canopy cover for the species found. To facilitate comparison of invasive plant distribution over time, we included results for the same 15 species from SOPN’s previous grid-point survey, completed in 2016, in this report’s table summaries and maps.

Key results include an increase in kochia, an increase in yellow bluestem, and incidental sightings of honey locust encroachment. Of particular concern is the expansion of Johnsongrass in the reconstructed prairie of Burn Unit 8. We recommend periodic chemical treatments of this and other non-native pasture grasses, such as yellow bluestem and smooth brome, in areas where they pose a threat to native grassland. As resources permit, we recommend mitigating the encroachment of honey locust with cut stump treatments. We have provided recommendations for controlling the dense patch of kochia along the nature trail if that area is a treatment priority. Where possible, combining chemical treatments with prescribed burns can increase success. Maps showing distribution and canopy cover for all detected species can be found in Appendix A.



Invasive plant monitoring at Fort Larned National Historic Site, 2025. NPS/Merran Owen

Dates of Survey: July 6–7, 2025

Field Crew: M. Owen (lead), S. Hedberg, E. Fitzpatrick

Data Availability: Data are hosted on the NPS Geospatial Portal and can be made available on request. Spatial data will be published in shapefile and kmz formats.

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Monitoring Results

Project Overview

In July of 2025, we surveyed a 150-m grid covering the full extent of FOLS, including the Santa Fe Trail Ruts unit. The survey grid is shown in Figure 1. Grid-point surveys are an element of our Exotic Plant–Early Detection Protocol and provide data on the extent and distribution of invasive plants within the park’s interior landscape. They are meant to monitor the spread of invasive plants over time and document infestations for which we recommend treatment. To sample grid points, surveyors walk a 10-m-radius circle and estimate cover for a customized list of 15 invasive species of concern to the park (Table 1) (see Monitoring Protocol section for further details on the Exotic Plant–Early Detection protocol). Key results are summarized below.

Maps showing species distribution and cover are presented in Appendix A (in alphabetical order by scientific name, Maps A-1 to A-11), and the frequency of each species, calculated as the percentage of grid points at which a given species was found, is shown in Table 1. A map of the Fort Larned prescribed burn units is provided for a geographic reference to different sections of the park (Figure 2).

Comparison to Prior Surveys

To facilitate comparison of invasive plant distribution and cover over time, this report includes results for the same 15 species from SOPN’s previous grid-point survey, completed in 2016. Both surveys used the same 150-m grid, but flooding in 2016 prevented some points from being monitored. The extent of both surveys is shown in Figure 1. The full 2016 dataset is hosted on the NPS Geospatial Portal and is available upon request. The 2016 survey was conducted in late May, and the 2025 survey was conducted in early July.

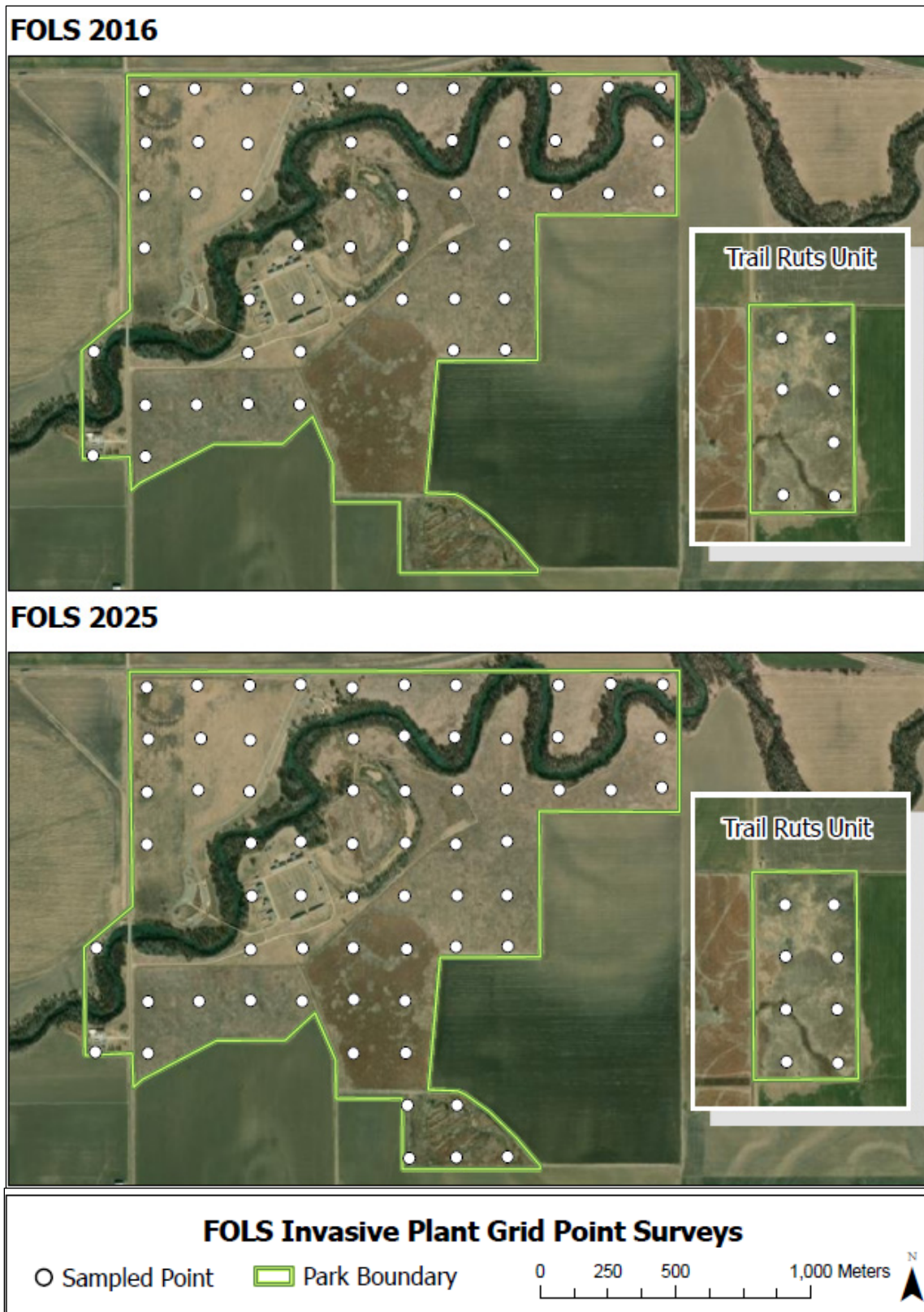


Figure 1. Invasive plant monitoring grids for the 2016 and 2025 surveys at Fort Larned National Historic Site. Grid points are 150 m apart. The full 72-point grid was sampled in 2025, but surveyors were only able to access 58 points in 2016 due to flooding. NPS figure

Table 1. Invasive plant species included in the 2025 FOLS invasive plant survey, listed from highest to lowest frequency, and then alphabetically for non-detected species. Frequency is calculated as the percentage of grid points at which a given species occurred. Frequencies of these species are shown from both the 2016 and 2025 surveys, but these numbers should not be compared directly. Both surveys used the same 150-m grid, but only 58 points were sampled in 2016 due to flooding, while the full 72 points were sampled in 2025.

Scientific Name	Common Name	Life Form	Duration	Frequency 2025	Frequency 2016
<i>Bromus inermis</i>	Smooth brome	Grass	Perennial	65%	84%
<i>Bromus japonicus</i>	Japanese brome	Grass	Annual	32%	14%
<i>Kochia scoparia</i>	Kochia	Forb	Annual	29%	19%
<i>Melilotus</i> sp.	Sweetclover	Forb	Perennial /Biennial	15%	3%
<i>Sorghum halepense</i>	Johnsongrass	Grass	Perennial	11%	2%
<i>Bothriochloa ischaemum</i>	Yellow bluestem	Grass	Perennial	10%	--
<i>Cynodon dactylon</i>	Bermudagrass	Grass	Perennial	7%	--
<i>Medicago sativa</i>	Alfalfa	Forb	Perennial	4%	--
<i>Digitaria sanguinalis</i>	Hairy crabgrass	Grass	Annual	3%	--
<i>Cirsium vulgare</i>	Bull thistle	Forb	Annual	--	2%
<i>Bromus tectorum</i>	Cheatgrass	Grass	Annual	--	--
<i>Carduus nutans</i>	Musk thistle	Forb	Annual /Biennial	--	--
<i>Cirsium arvense</i>	Canada thistle	Forb	Perennial	--	--
<i>Salsola tragus</i>	Russian thistle	Forb	Annual	--	--
<i>Verbascum thapsus</i>	Mullein	Forb	Biennial	--	--

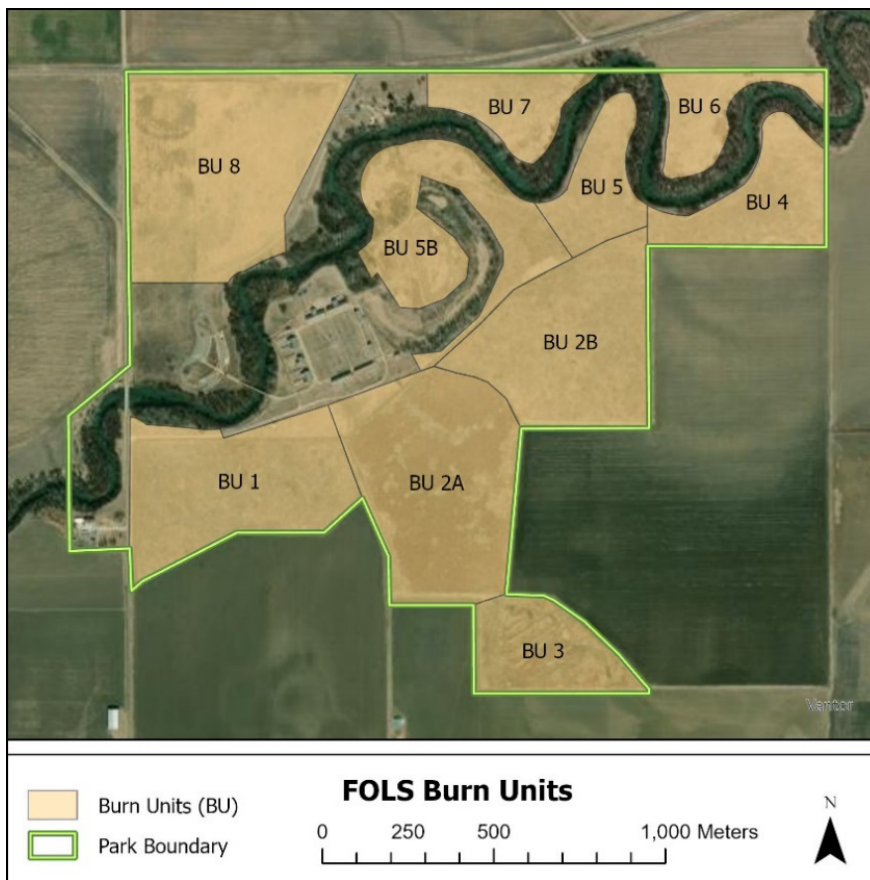


Figure 2. Burn units of Fort Larned National Historic Site. NPS figure

Key Results

- We recorded occurrences for nine out of the 15 species surveyed (Table 1). Nearly all showed an increase in frequency from 2016, the most concerning of which are discussed below. All species detected in 2025 were previously known to occur at the park, but many had not appeared in prior grid point surveys. Treatment recommendations are in the following section.
- Our data show a clear increase in Johnsongrass (*Sorghum halepense*, Map A-11), a non-native pasture grass, in the reconstructed prairie of Burn Unit 8. This is a notoriously invasive, sod-forming perennial that could pose a threat to the long-term success of the revegetation project.
 - In 2016, Johnsongrass was recorded once in Burn Unit 8, along the western edge, where it has consistently shown up in Exotic Plant–Early Detection roadside surveys. By 2025, it had reached 26-50% cover at grid points along the western edge and was detected at trace to moderate amounts (up to 25% cover) at grid points across the burn unit.
 - Currently, patch sizes remain small, but we expect that Johnsongrass will continue expanding through the revegetated area, wherever soils are moist enough to support it.
- One reason for the Johnsongrass invasion of Burn Unit 8 may be the decline of a similar non-native pasture grass in the area, smooth brome (*Bromus inermis*, Map A-2).

- Smooth brome was the most frequent species found in our survey. Much of the park's grassland was converted to smooth brome pasture during its ranching era (1880s to 1960s), and the park has since restored select areas. We found two areas where smooth brome poses a threat to native grassland—the reconstructed prairie in Burn Unit 8 and the remnant prairie in Burn Unit 2A.
- Our data show a decline in distribution and cover in Burn Unit 8 from 2016 to 2025. This suggests that the species may have been successfully controlled during the active revegetation of that area. However, smooth brome continues to persist in the unit and remains at 6–25% cover at grid points along the western edge, where it could pose a threat of reinvasion.
- Burn Unit 2A holds the majority of the fort's remaining tallgrass prairie. Smooth brome is currently well established in the unit and reaches 51–100% cover at one-third of the grid points. As this unit was unable to be surveyed in 2016, we added a map of the 2013 grid point survey results to the appendix (Map A-3). The data show a dramatic increase in smooth brome over the years, from occurring at two grid points in 2013 at 6-25% cover, to the current state.
- We found an increase in frequency in a third non-native pasture grass, yellow bluestem (*Bothriochloa ischaemum*, Map A-1) in the northeast region of the park. This is a drought-tolerant, invasive bunchgrass capable of outcompeting native species and forming monocultures. It could become problematic if it spreads to areas with native or reconstructed prairie. However, at present our surveys have only found it growing in the fort's smooth brome pastures.
- Kochia (*Kochia scoparia*, Map A-8) has become well established in the oxbow east of the fort and floodplains along the river. Our survey also detected a dense patch that had formed in the smooth brome pastures along the nature trail northeast of the fort, where it is visible to visitors.
- Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), Russian thistle (*Salsola tragus*), and mullein (*Verbascum thapsus*) continue to be absent from our grid-point surveys (see Table 1), and the single occurrence of bull thistle (*Cirsium vulgare*) recorded in 2016 was not observed in 2025 (Map A-5).
- The survey crew reported incidental sightings of honey locust (*Gleditsia triacanthos*) in Burn Unit 3 and in the riparian zone along the Pawnee River. This was not one of the target species of our survey, but the amount of woody encroachment was sufficient to bring it to the park's attention.
 - We observed a small thicket of trees large enough to reproduce in Burn Unit 3, and the occasional mature tree in the riparian zone. We will add honey locust to our surveys in future years and recommend the park begin mitigating its spread.

Treatment Recommendations

Johnsongrass

- Johnsongrass (Figure 3) is an aggressive invader of moist, disturbed soils. Initial spread is primarily accomplished through its extensive and fast-growing root/rhizome network. With Johnsongrass, the root/rhizome network may account for over half of the plant's biomass (Klein and Smith 2021, Travlos et al. 2019). Given the difficulty of controlling this grass once established, we strongly recommend a series of chemical treatments in Burn Unit 8 while patch sizes remain small.

- Chemical treatments are necessary for control and will likely need to be applied for multiple years to deplete the root/rhizome network. Glyphosate is one of the more commonly used herbicides (Klein and Smith 2021, Travlos et al. 2019).
- We recommend glyphosate applications at either the boot stage (the reproductive stage immediately prior to seedhead emergence) or in early fall, when herbicide is most likely to be translocated to the roots. Spring applications are often countered by rapid rhizomatous growth (Shilling and McCullough 2022).



Figure 3. Photos taken during the 2025 survey of Johnsongrass patches invading Burn Unit 8. The photo on the right shows some of the characteristics used in identification—the purple-colored, pyramidal seedhead and white mid-vein of the leaf. NPS/Merran Owen

Smooth Brome

- Smooth brome is a cool-season, sod-forming grass that uses its extensive rhizomatous root network to invade native prairie in a manner similar to Johnsongrass. As it is a cool-season grass, it's active earlier in the spring than many of the native grasses, which are primarily warm-season. This allows for a window of treatment, and a common strategy is the late spring burn, at a time when cool-season and woody species are most vulnerable (Salesman & Thomsen 2011). However, we would not rely on fire alone to provide the control needed and recommend a primary focus on chemical treatments.
 - Smooth brome is susceptible to glyphosate, allowing it to be treated concurrently with Johnsongrass in Burn Unit 8. Incorporating smooth brome into periodic fall treatments when herbicide is most likely to be translocated to the root/rhizome network should help address new patches of both species. If glyphosate proves ineffective, research suggests that imazapyr offers better control of smooth brome, but it may be more damaging to native species (Bahm et al. 2001).
 - Control within Burn Unit 2A would be more difficult, as the species is intermixed with native tallgrasses. Integrating prescribed burns with chemical treatments may be the most strategic

approach. Regular late-spring burns, during the smooth brome boot stage, combined with careful spot-spray in the fall could help prevent further invasion into the remnant prairie.

Yellow Bluestem

- Yellow bluestem is an aggressive warm-season bunchgrass and a common invasive of mixed-grass prairie. At the park, it is still low in cover and not yet widely distributed, but it will likely continue to spread. This makes it a good candidate for early treatment.
 - Studies have shown good results through multiple chemical treatments within the same growing season. For example, Robertson et al. (2013) achieved a significant reduction of cover of yellow bluestem in western Oklahoma through glyphosate applications performed in May, August, and September of the same year. A single herbicide treatment each year did not provide control.

Kochia

- Kochia is a highly invasive annual forb that often colonizes seasonally flooded soils, such as the oxbow east of the fort. Controlling kochia in the oxbow is not likely to be successful long-term without revegetation. However, mechanical or chemical control within the smooth brome pastures should be feasible, if desired by the park. Treating the kochia may allow smooth brome to overtop and outcompete it.
 - Kochia reproduces only by seed, and while each plant may produce thousands, seeds do not remain viable for more than a few years (Friesen et al. 2009). Common strategies used to control seed production are well-timed mowing or herbicide treatments.
 - Chemical treatments will control kochia if applied while the plants are young and actively growing, but kochia is a common agricultural weed and many herbicide-resistant biotypes have evolved (Friesen et al. 2009). Herbicide mixtures are now often necessary for control (Burton et al. 2014).
 - Mowing may temper seed production if done at the correct life stage, although it will not kill the plant. To best control seed production, we recommend mowing when flowers first appear. Populations can recover quickly if left unmonitored, and mowing at the incorrect life stage is less effective (Friesen et al. 2009).

Honey Locust

- Although native to the area, honey locust is a source of woody encroachment in Kansas grasslands. The species is a long-lived deciduous tree known for producing thorns along its trunk and branches. Honey locust begins producing fruit at three to five years of age and is quite prolific, with seeds that remain viable for up to twenty years (State of Queensland 2016).
 - Mechanical removal or prescribed burns may be necessary to clear thickets and open the canopy. Honey locust seedlings are susceptible to fire, but older plants are known to resprout after fire or cutting (State of Queensland 2016). Herbicide application is an effective treatment in this case.
 - A 2016 study in Kansas tested the effectiveness of different herbicides on honey locust in cut stump and basal bark treatments. Aminopyralids caused the highest rates of mortality in both methods (an average of 97%) over a 12-month period (Harmony 2016).

- Regular prescribed burns in the late spring should help keep encroachment in check, once larger trees and saplings are removed.

Data Availability

Distribution and cover of all invasive plant species recorded in 2025 are summarized in maps in Appendix A, presented in alphabetical order by scientific name. All data are hosted on the NPS Geospatial Portal and available to FOLS park staff and Invasive Plant Management Teams (IPMTs) upon request. Our Exotic Plant–Early Detection data will be published annually on datastore in both shapefile and kmz formats. These are spatial data files that can be viewed in GIS software such as ESRI products, QGIS, and Google Earth. These files may also be uploaded to GPS units or used in apps such as Avenza, allowing for field navigation to specific infestations. Shapefiles come complete with a table of attributes for each spatial feature, such as the cover of each plant at a given grid point.

To further discuss the results of the 2025 invasive plant survey, please contact the SOPN Vegetation Ecologist or IPMT staff.

Monitoring Protocol

SOPN monitors pathways of invasive plant introduction at network parks according to the Southwest Network Collaboration (SWNC) Exotic Plant–Early Detection Protocol (currently unpublished). The areas sampled are typically linear transects along roads, trails, boundary lines, and stream channels that are at high risk for invasive plant invasion and infestation. In select years, invasive plant data are also collected at predetermined grid points spaced 150 m apart, covering the entire park acreage minus any areas excluded for safety or difficulty of access. Grid-point locations at FOLS are shown in Figure 1. Surveys of additional areas, referred to as “extra-area surveys,” may also be completed upon request from park staff.

To sample grid points, surveyors record the invasive plant species found within a 10-m radius of the point, as well as canopy cover and phenology (e.g., flowering or fruiting stage) for each species. Surveyors measure canopy cover via ocular estimation and record it using a series of classes: 1–5%, 6–25%, 26–50%, and 51–100%. When sampling transects, surveyors walk the transect length and map invasive plant infestations that occur within 30 m of the center line. Infestations are documented as points or polygons. Points are recorded as one of three size classes: under 1-m radius, 1.1 to 5-m radius, and 5.1 to 10-m radius. Infestations larger than a 10-m radius, or those that exist as long, continuous stretches, are recorded as polygons. Data collected for infestations include plant species name, the size of the patch, canopy cover, number of plants present in the patch, phenology, and level of site disturbance.

SOPN surveys for a short list of species that is customized to each park. The monitoring list for FOLS (see Table 1) was initially drawn from the historic site’s Natural Resource Condition Assessment (NRCA), completed by Struthers et al. (2014). In the NRCA, invasive plants found in 2011–2013 FOLS surveys were ranked across a series of factors, following a system designed by Morse et al. (2004). Factors included the plant’s ecological impact, management difficulty, current distribution and abundance, and trends in distribution and abundance. For further detail, see the FOLS NRCA (Struthers et al. 2014). We have adapted the original NRCA monitoring list to include aggressive invasives found at low levels in our vital signs

monitoring, agricultural invasives that may enter the historic site from adjacent cropland, and species of concern to native grasslands of the region.

Please contact the SOPN Vegetation Ecologist for further customization of the FOLS monitoring list (Table 1). Additional species will be added as requested.

Report Disclaimer

This report received peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information. Peer review helps to ensure that the information is scientifically credible, technically accurate, appropriate to its intended audience, and effectively presented. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were summarized and interpreted within the guidelines of the protocols. Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

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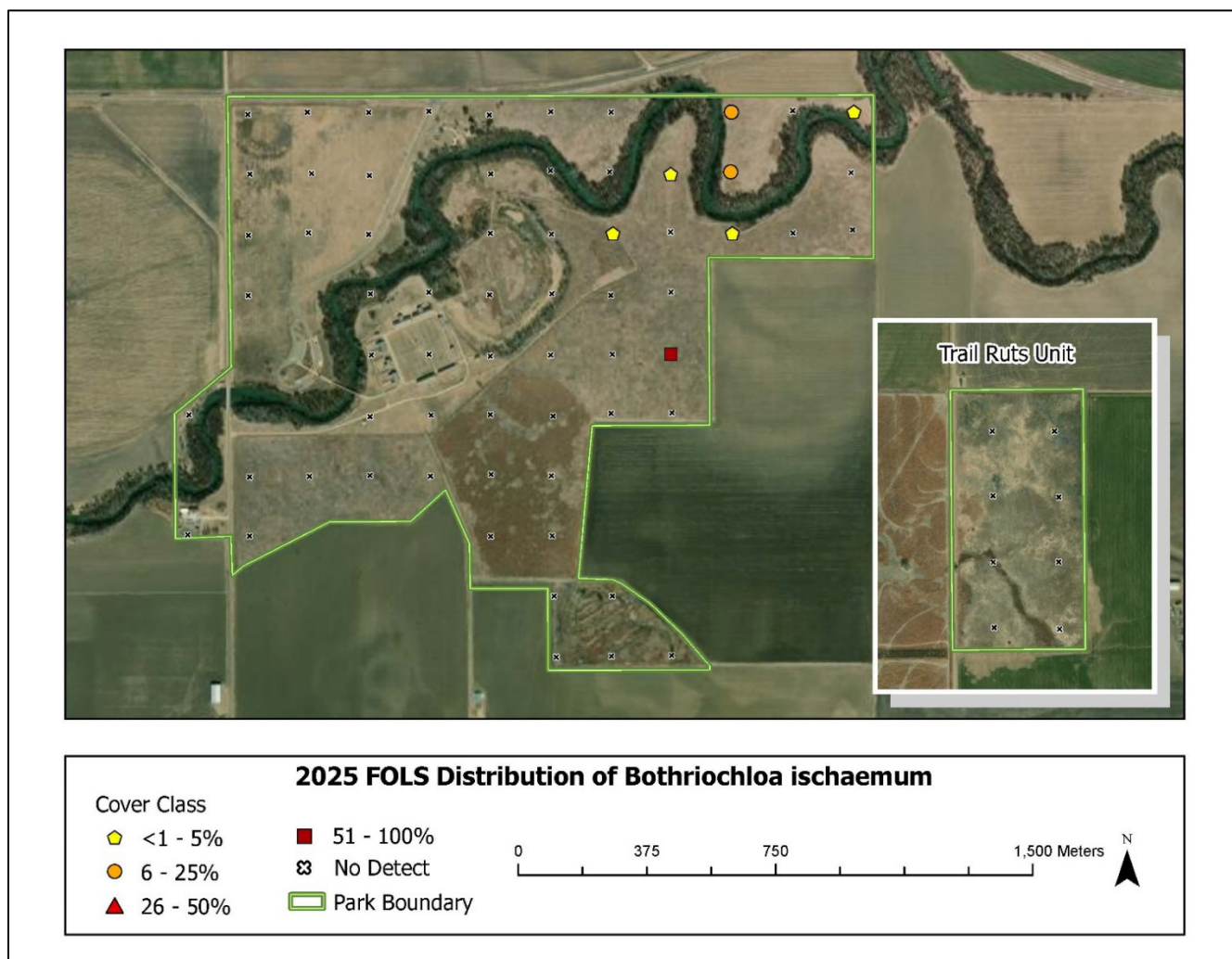
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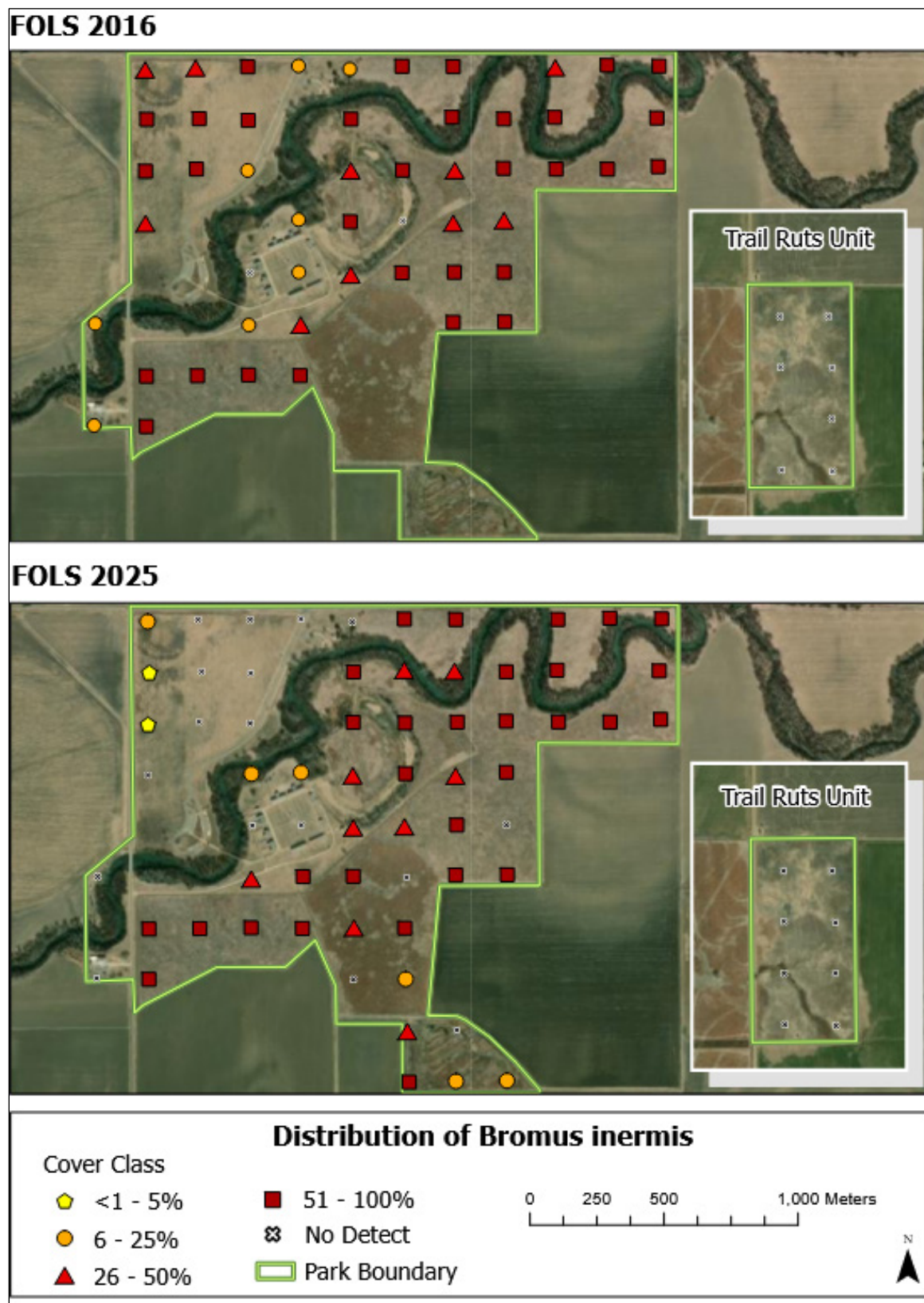
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Appendix A. Fort Larned National Historic Site (FOLS) Invasive Plant Monitoring Survey Maps, 2025

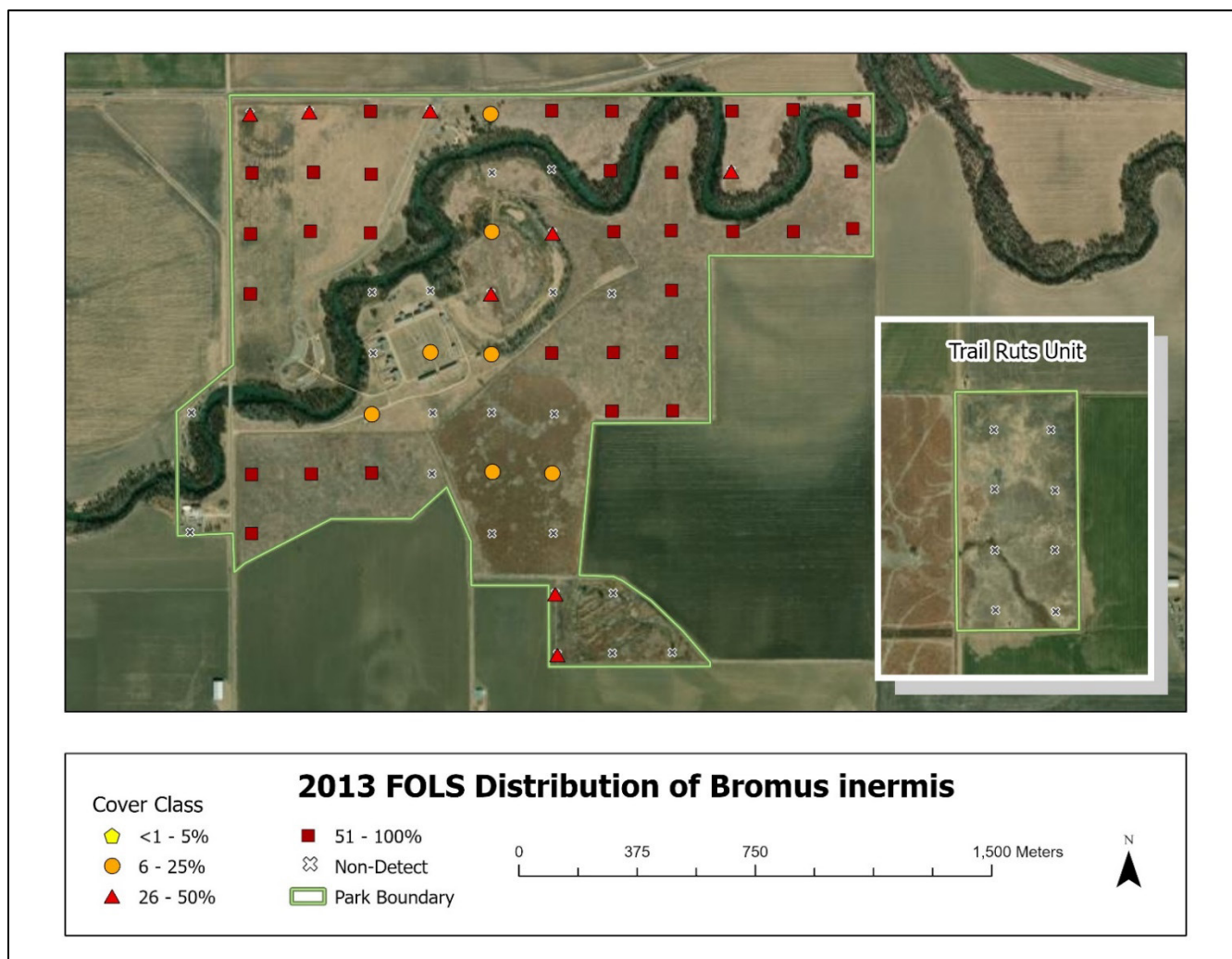
Map A-1. Yellow bluestem (*Bothriochloa ischaemum*) distribution and canopy cover recorded in the 2025 survey. This species was not observed in 2016. NPS figure



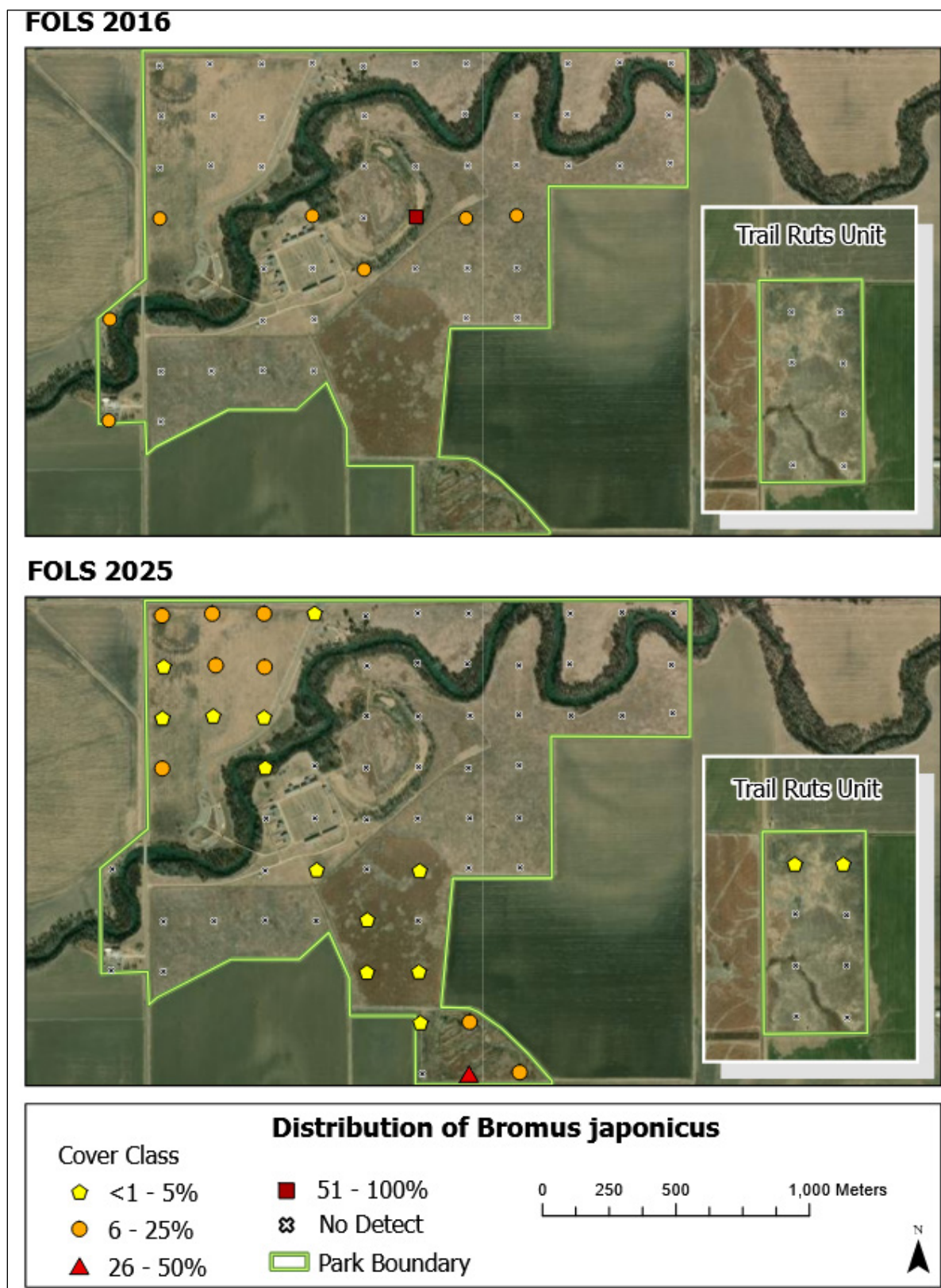
Map A-2. Smooth brome (*Bromus inermis*) distribution and canopy cover recorded in 2016 (top) and 2025 (bottom) surveys. NPS figure



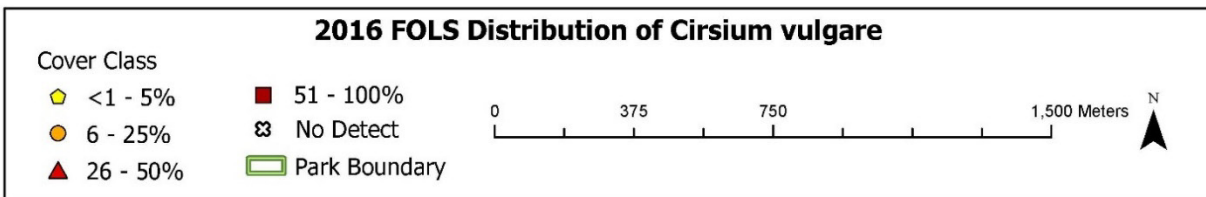
Map A-3. Smooth brome (*Bromus inermis*) distribution and canopy cover recorded in 2013 surveys. NPS figure



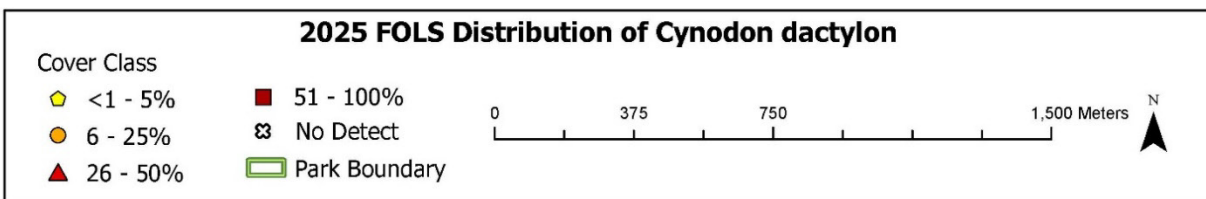
Map A-4. Japanese brome (*Bromus japonicus*) distribution and canopy cover recorded in 2016 (top) and 2025 (bottom) surveys. NPS figure



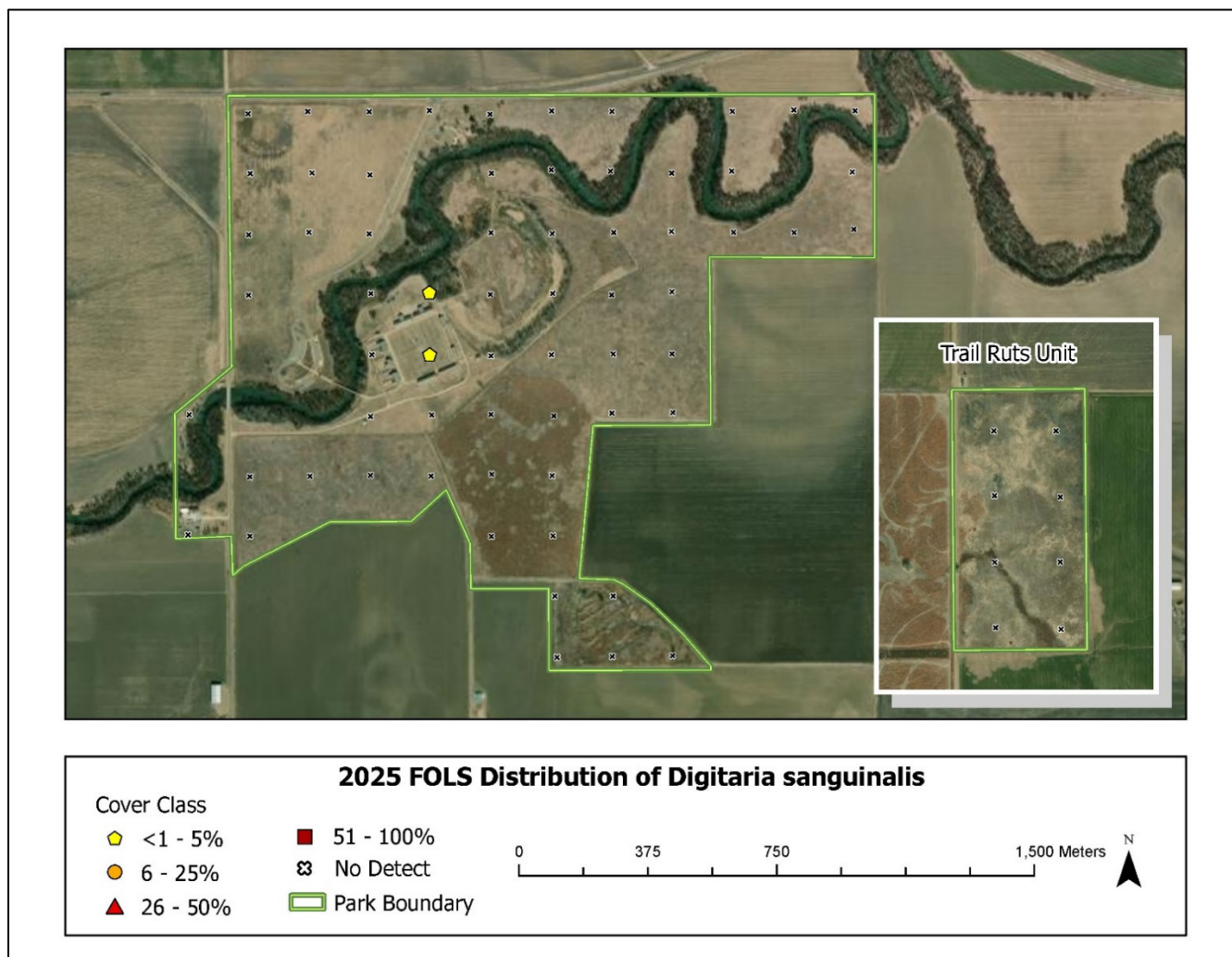
Map A-5. Bull thistle (*Cirsium vulgare*) distribution and canopy cover recorded in the 2016 survey. This species was not observed in 2025. NPS figure



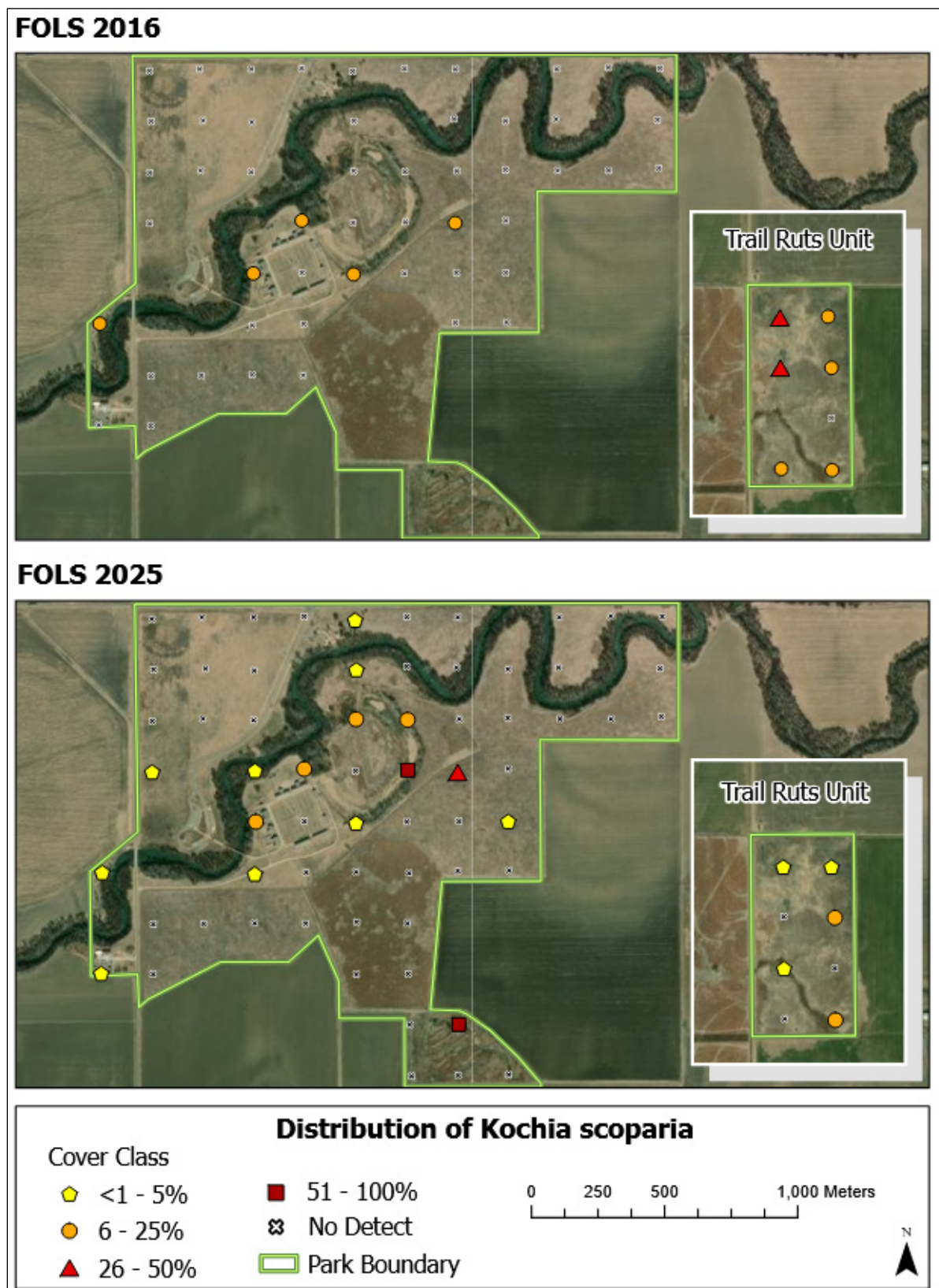
Map A-6. Bermudagrass (*Cynodon dactylon*) distribution and canopy cover recorded in the 2025 survey. This species was not observed in 2016. NPS figure



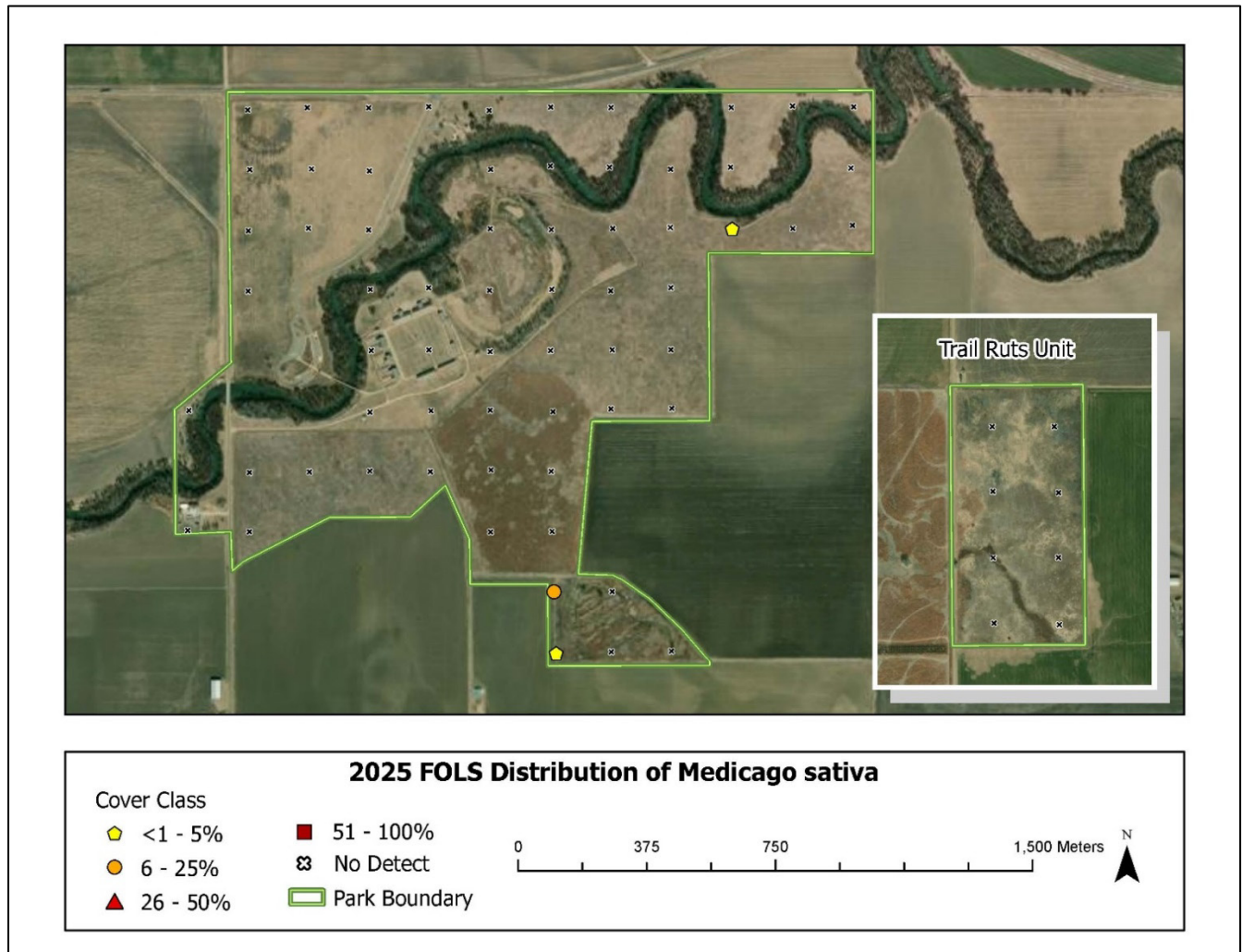
Map A-7. Hairy crabgrass (*Digitaria sanguinalis*) distribution and canopy cover recorded in the 2025 survey. This species was not observed in 2016. NPS figure



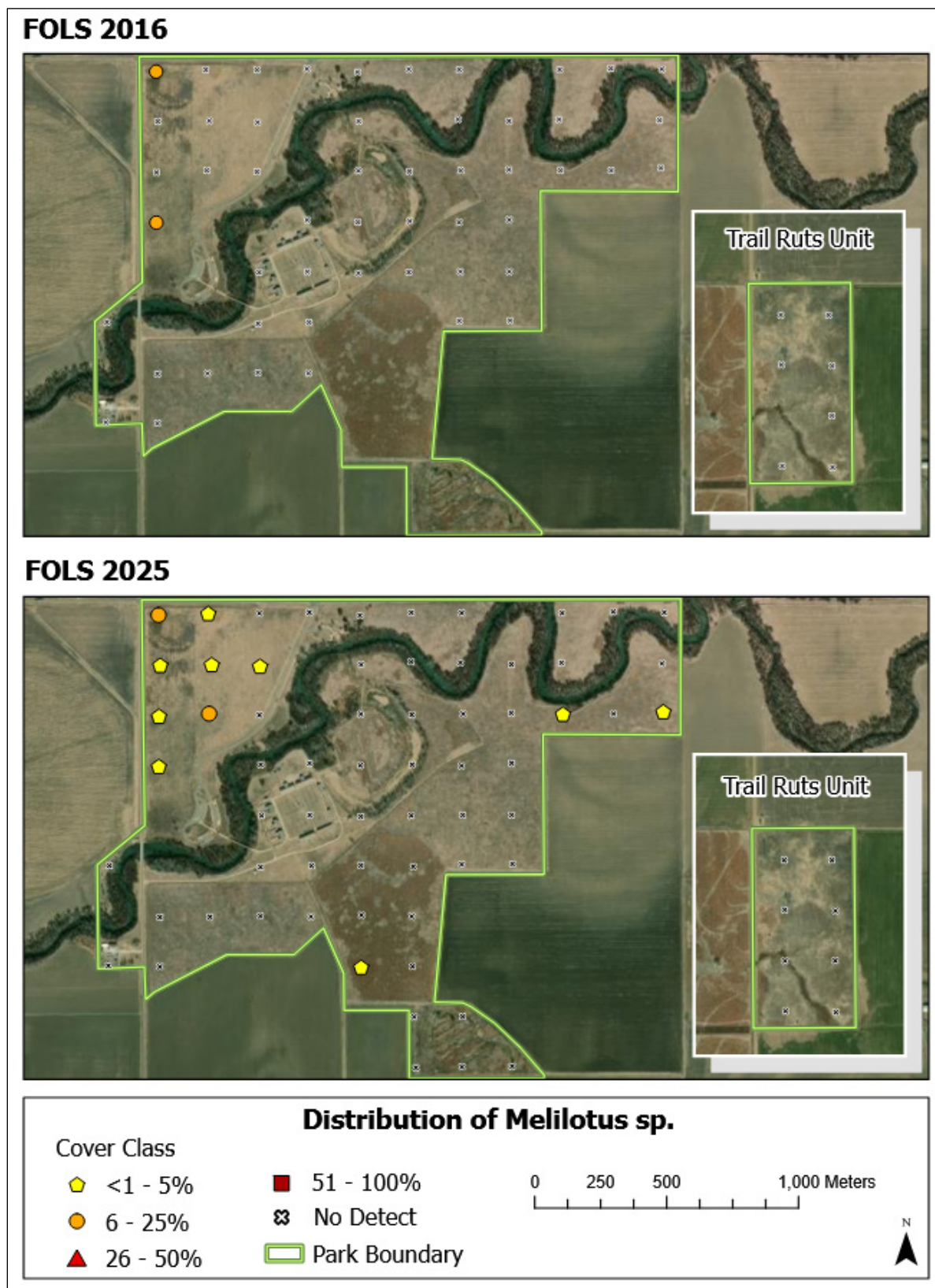
Map A-8. *Kochia (Kochia scoparia)* distribution and canopy cover recorded in 2016 (top) and 2025 (bottom) surveys. NPS figure



Map A-9. Alfalfa (*Medicago sativa*) distribution and canopy cover recorded in the 2025 survey. This species was not observed in 2016. NPS figure



Map A-10. Sweetclover (*Melilotus* sp.) distribution and canopy cover recorded in 2016 (top) and 2025 (bottom) surveys. NPS figure



Map A-11. Johnsongrass (*Sorghum halepense*) distribution and canopy cover recorded in 2016 (top) and 2025 (bottom) surveys. NPS figure

