



Sand Creek Massacre National Historic Site Revegetation Monitoring Summary—2025

Summary

In July of 2024 and 2025, the Southern Plains Inventory & Monitoring Network (SOPN) completed grid-point surveys in two newly revegetated areas at Sand Creek Massacre National Historic Site (NHS). The areas surveyed were part of the 2022 land acquisition and are former cropland. Each area has been drill seeded once with native plants—one small area in March of 2023 and the larger, second area in March of 2024. We surveyed these areas along a 100-m grid and recorded the cover of native grasses, native forbs, non-native grasses, non-native forbs, bare soil, and soil disturbance. In 2025, we began recording cover of individual native grass species with 5% or greater cover.

Mean cover of native grasses showed a substantial increase from 2024 to 2025, especially in the more recently seeded area. Mean cover of other functional groups stayed relatively the same, except for a rise in non-native forbs in some areas. Individual native grass species recorded in 2025 were grama grasses, sand dropseed, and switchgrass, but the species dominant to regional shortgrass prairies, blue grama, was only present in trace amounts. The functional group with the highest mean cover in nearly every year/section was non-native forbs, with two main species observed, kochia and Russian thistle. We recommend controlling these species and encouraging establishment of native grasses through regular mowing treatments—by mowing the seeded areas to 4–6 inches once vegetation reaches 8–10 inches in height—for the span of the two growing seasons following seeding. Table summaries and figures are included in the body of this report, and maps showing distribution and canopy cover for all functional groups are located in Appendix A.



Revegetation monitoring at Sand Creek Massacre National Historic Site, 2025. The yellow flowers are Maximillian sunflower (*Helianthus maximiliani*), one of the many seeded species. NPS photo

Dates of Survey: July 20–22, 2024, and July 19–22, 2025

Field Crew: K. Fahey, L. Renteria, M. Owen (leads), E. Fitzpatrick, C. Barry, and M. Valdovinos

Data Availability: Data are hosted on NPS Geospatial Portal and can be made available upon request, along with photos. A data package will be published once the project is complete.

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Monitoring Results

Project Overview

Sand Creek Massacre NHS (SAND) underwent a significant land expansion in 2022 that nearly doubled the park in size. The expansion included about 800 acres of former agricultural land that historically supported shortgrass steppe and sand sage communities. The park has been working in partnership with Colorado Parks and Wildlife to revegetate this acreage with native grasses and forbs. At the time of this report, drill seeding had been done in two sections of the park: approximately 39 acres in Public Land Survey System (PLSS) Section 18 in March of 2023, and approximately 160 acres in PLSS Section 20 in March of 2024. The acreage was active farmland before seeding, and seeding was done into stubble and a mix of early successional plant species, some non-native. The project proposal calls for drill seeding to continue in these sections on an annual basis until all former cropland has been seeded, funding dependent. Section 18 is at the northern edge of the park and is just to the east of the park's pre-expansion acreage. Section 20 is along the eastern edge of the new land acquisition (Figure 1).

Methods

The Southern Plains Inventory and Monitoring Network (SOPN) created a repeatable method for measuring the success of the revegetation project, adapted from our invasive plant grid-point monitoring. We generated a 100-m grid over the drill-seeded acreage and will extend it as new land is seeded (see Figure 1). A total of eight grid points were generated in the seeded acreage of Section 18, and 64 grid points were generated in the seeded acreage of Section 20. To sample grid points, surveyors walked a 5-m-radius circle around each point and recorded percent canopy cover of the following variables: total native grasses, total non-native grasses, total native forbs, total non-native forbs, bare soil, and soil disturbance. In 2025, we also recorded cover for individual native grass species found to occur at 5% cover or greater (these species continued to be counted in the total native grass cover as well). We measured canopy cover via ocular estimation and recorded it using a series of classes: 1–5%, 6–25%, 26–50%, 51–75%, and 76–100%. Total cover by functional group (e.g., native grass) does not take overlapping species into account. We designated a subset of grid points as photo points on alternating rows and columns. At each photo grid point we took four photos—one in each cardinal direction. We have surveyed the two sections twice, in July 2024 and July 2025, and plan to continue monitoring revegetated areas for two years post-seeding.

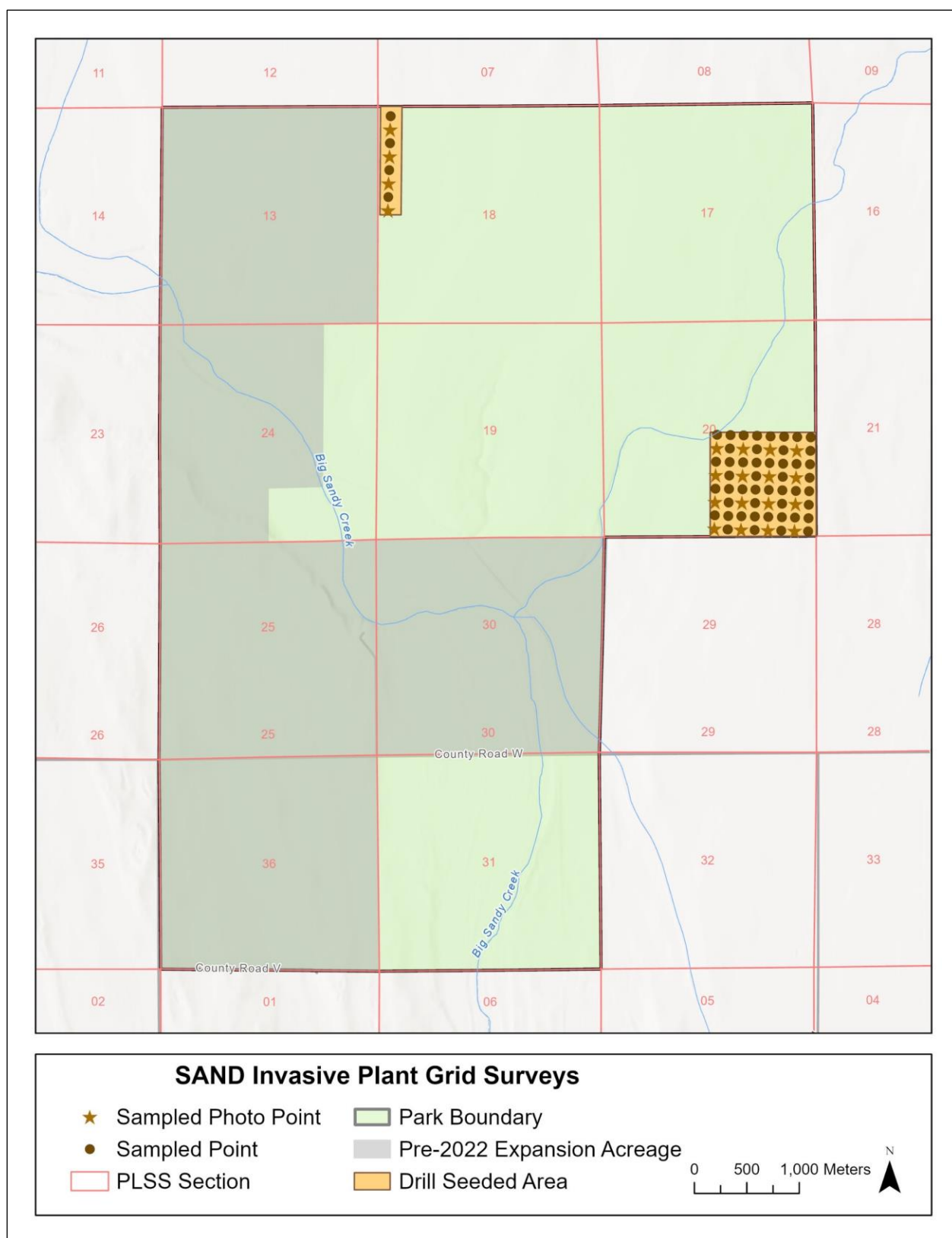


Figure 1. Map showing all revegetation monitoring grid-point and photo point locations at Sand Creek Massacre National Historic Site. Grid points are 100 m apart, and areas with water or with >30% slope are excluded. Public Land Survey System (PLSS) sections are overlaid for geographic reference. NPS figure

Key Results

- Native grass cover increased substantially in both sections from 2024 to 2025 (Tables 1 and 2; Map A-1). Mean cover doubled in the more recently seeded 160 acres of Section 20, and histograms of the cover class distribution (Figures 2 and 3) show a shift towards higher values in both sections.
 - The March 2023 seeding in Section 18 appears to be the more successful of the two, with native grass cover reaching 28% by the summer of 2024.
 - The March 2024 seeding in Section 20 had not shown much success by the time of our summer survey, but the increase in mean native grass cover from 14% in 2024 to 31% by July of 2025 suggests that seeded species continued to germinate and grow.
- Native grass species with cover >5% in 2025 were grama grasses (*Bouteloua gracilis* and *curtipendula*), sand dropseed (*Sporobolus cryptandrus*), and switchgrass (*Panicum virgatum*) (see Tables 1 and 2; Maps A-2 and A-3), all included in the seed mix.
 - This differed from 2024, when the most abundant native grass observed in the seeded area of Section 20 was witchgrass (*Panicum capillare*), an opportunistic native annual that was not seeded. Continued monitoring will determine if we are seeing a true trend from opportunistic annuals to seeded perennials in that area, but this is a positive sign.
 - One note of concern—the species that most commonly dominates regional shortgrass prairies, blue grama (*Bouteloua gracilis*), was absent from the seeded area in Section 20 and only present in trace amounts in the seeded area of Section 18.
- Non-native forbs had among the highest cover in both seeded areas, often higher than native grasses (see Tables 1 and 2; Map A-6). Some grid points within Section 20 had non-native forb cover of 75% or greater.
 - The most dominant species noted by the survey crew were kochia (*Kochia scoparia*) and Russian thistle (*Salsola tragus*). These are annual forbs well known to SAND—our invasive plant surveys have found them to be pervasive and increasing in distribution over time (Owen et al. 2022).
 - Herbicide treatments or mowing will be pivotal in controlling these species and allowing native plants to establish. We provide management recommendations on Page 7 of this report.
- Non-native grasses and native forbs were present in low amounts.
 - The most common non-native grass observed at grid points by the survey crew was stinkgrass (*Eragrostis cilianensis*), a moderately invasive annual species known to occur at the park.
 - Native forbs were most commonly opportunistic species that were not a part of the seed mix (sand mats; *Chamaesyce*). In 2025, Maximillian sunflower (*Helianthus maximiliani*) contributed to an increase in native forb cover in Section 20. This was a seeded species.

Table 1. Mean cover for plant functional groups and individual species observed in July 2024 and 2025 during SAND Revegetation Monitoring in Section 18. In Section 18, the seeded area was ~39 acres with eight grid points.

Functional Group/ Species	Mean Cover 2024	Mean Cover 2025
Total Native Grasses	28%	39%
Total Native Forbs	1%	3%
Total Non-native Grasses	0%	<1%
Total Non-native Forbs	30%	28%
Bare Soil	32%	11%
Soil Disturbance	1%	2%
Blue grama (<i>Bouteloua gracilis</i>)	NA	4%
Sideoats grama (<i>Bouteloua curtipendula</i>)	NA	22%
Switchgrass (<i>Panicum virgatum</i>)	NA	0%
Sand Dropseed (<i>Sporobolus cryptandrus</i>)	NA	7%

* As cover is recorded by category, mean cover is calculated by taking the mid-point of the category recorded for each species.

Table 2. Mean cover for plant functional groups and individual species observed in July 2024 and 2025 during SAND Revegetation Monitoring in Section 20. In Section 20, the seeded area was ~160 acres with 64 grid points.

Functional Group/ Species	Mean Cover 2024	Mean Cover 2025
Total Native Grasses	14%	31%
Total Native Forbs	8%	11%
Total Non-native Grasses	2%	<1%
Total Non-native Forbs	34%	42%
Bare Soil	36%	15%
Soil Disturbance	1%	0%
Blue grama (<i>Bouteloua gracilis</i>)	NA	0%
Sideoats grama (<i>Bouteloua curtipendula</i>)	NA	3%
Switchgrass (<i>Panicum virgatum</i>)	NA	6%
Sand Dropseed (<i>Sporobolus cryptandrus</i>)	NA	7%

* As cover is recorded by category, mean cover is calculated by taking the mid-point of the category recorded for each species.

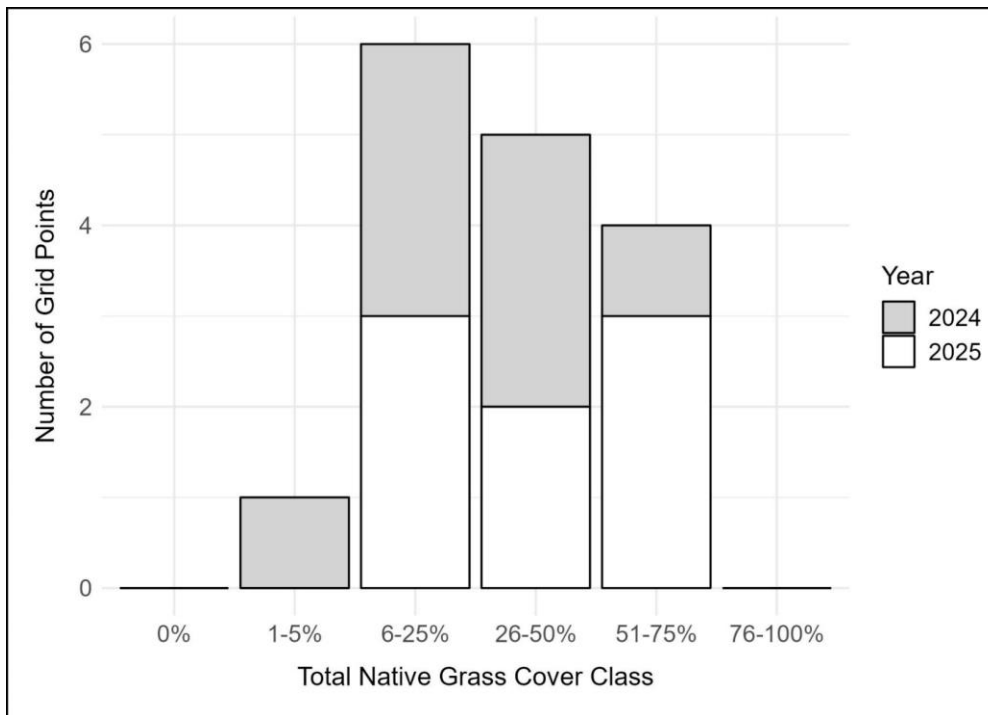


Figure 2. Histogram depicting the distribution of total native grass canopy cover in the 39 seeded acres of Section 18 (n=8). Canopy cover was recorded in a series of classes (e.g., 1–5%, 6–25%) for both 2024 (gray) and 2025 (white). The distribution of native grass cover shifted towards higher values in 2025. NPS figure

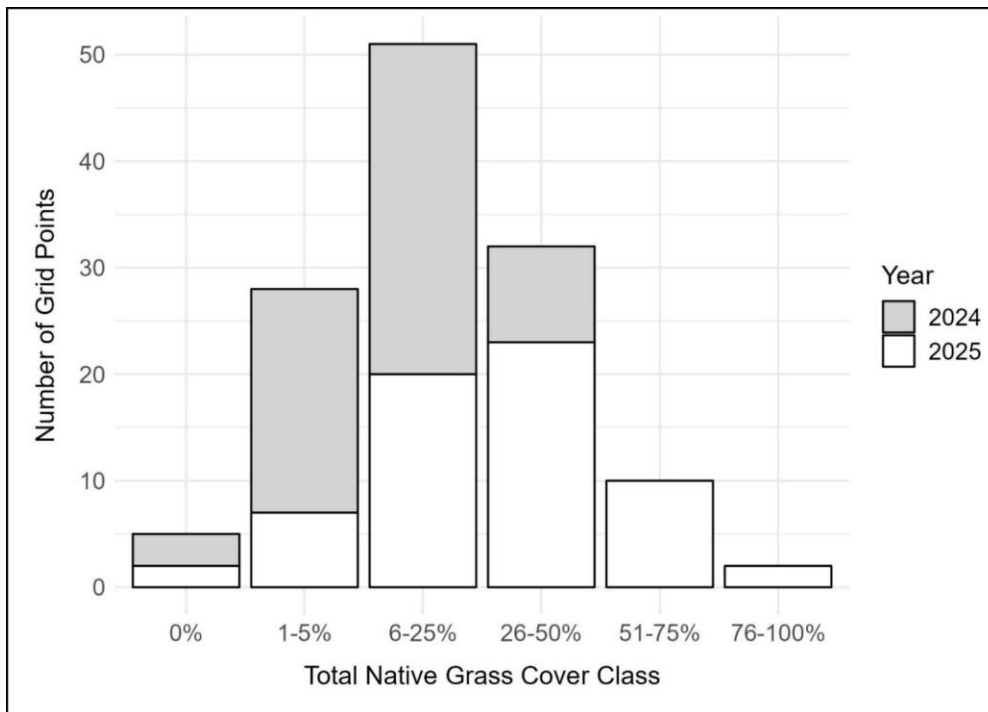


Figure 3. Histogram depicting the distribution of total native grass canopy cover in the 160 seeded acres of Section 20 (n=64). Canopy cover was recorded in a series of classes (e.g., 1–5%, 6–25%) for both 2024 (gray) and 2025 (white). The distribution of native grass cover shifted markedly towards higher values in 2025. NPS figure



Photo points from Section 20, seeded March 2024 and photographed in 2025. These two grid points represent some of the highest native grass and exotic forb cover, respectively, in that section. On the left, sand dropseed is the primary native grass seen; in 2025, this species had the highest cover in that section's seeded acreage (Table 2, Map A-3). The photo on the right is from the northwest corner of Section 20's seeded acreage, where exotic forb cover reached $\geq 75\%$. The dominant species seen in the photo is kochia. NPS photos

Management Recommendations

Restoration and Monitoring

- We encourage the park to continue drill seeding the newly acquired agricultural land as funding allows. These areas would be at high risk of colonization by invasive plant species if left fallow.
- We recommend reseeding the northwest corner of the 160 acres in Section 20, as that area continues to show low native grass and high non-native forb cover.
- We recommend reseeding the acreage in Section 20 with the dominant shortgrass of the area, blue grama (*Bouteloua gracilis*).
- SOPN will continue performing grid point surveys across seeded acreage for two years post-seeding, and then upon request of park staff.

Invasive Species Control

Kochia and Russian thistle were the primary non-native forbs found in our survey. We discussed treatment recommendations for these species in our 2022 SAND Exotic Plants Monitoring Summary (Owen et al. 2022), but will reemphasize a few points here.

- These species are highly invasive annual forbs with a significant presence at the park (Owen et al. 2022). Kochia and Russian thistle reproduce by seed, which they generate by the thousands (Friesen et al. 2009, Beckie and Francis 2009). Common strategies used to control seed production are well-timed mowing or herbicide treatments.

- Chemical treatments will control kochia and Russian thistle if applied while the plants are young and actively growing, but broadleaf herbicides often reduce the cover and biodiversity of native forbs as well. 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).
- Although mowing does not kill these plants, or necessarily prevent them from producing a crop of seeds, it may temper seed production (Friesen et al. 2009). Recommendations specific to the project (prepared by the Biological Resources Division of NRSS) advise controlling non-native species for the first two growing seasons following seeding by mowing the seeded areas to 4–6 inches once vegetation reaches 8–10 inches in height. The timing is key—mowing of taller vegetation can create a layer of mulch thick enough to kill or stunt young native grass seedlings. Mowing should be maintained until weed pressure subsides for the season, meaning that multiple treatments will likely be necessary.

Literature Cited

- Beckie, H.J., and A. Francis. 2009. The biology of Canadian weeds. 65. *Salsola tragus* L. (updated). Canadian Journal of Plant Science 89(4):775–89.
- Burton, N., S.W. Shirriff, and H.J. Beckie. 2014. Response of glyphosate-resistant kochia (*Kochia scoparia* L. Schrad.) to alternative herbicides. Canadian Journal of Plant Science 94(8):1407–1411.
- Friesen, L.F., H.J. Beckie, S.I. Warwick, and R.C. Van Acker. 2009. The biology of Canadian weeds. 138. *Kochia scoparia* (L.) Schrad. Canadian Journal of Plant Science 89:141–167.
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Report Disclaimer

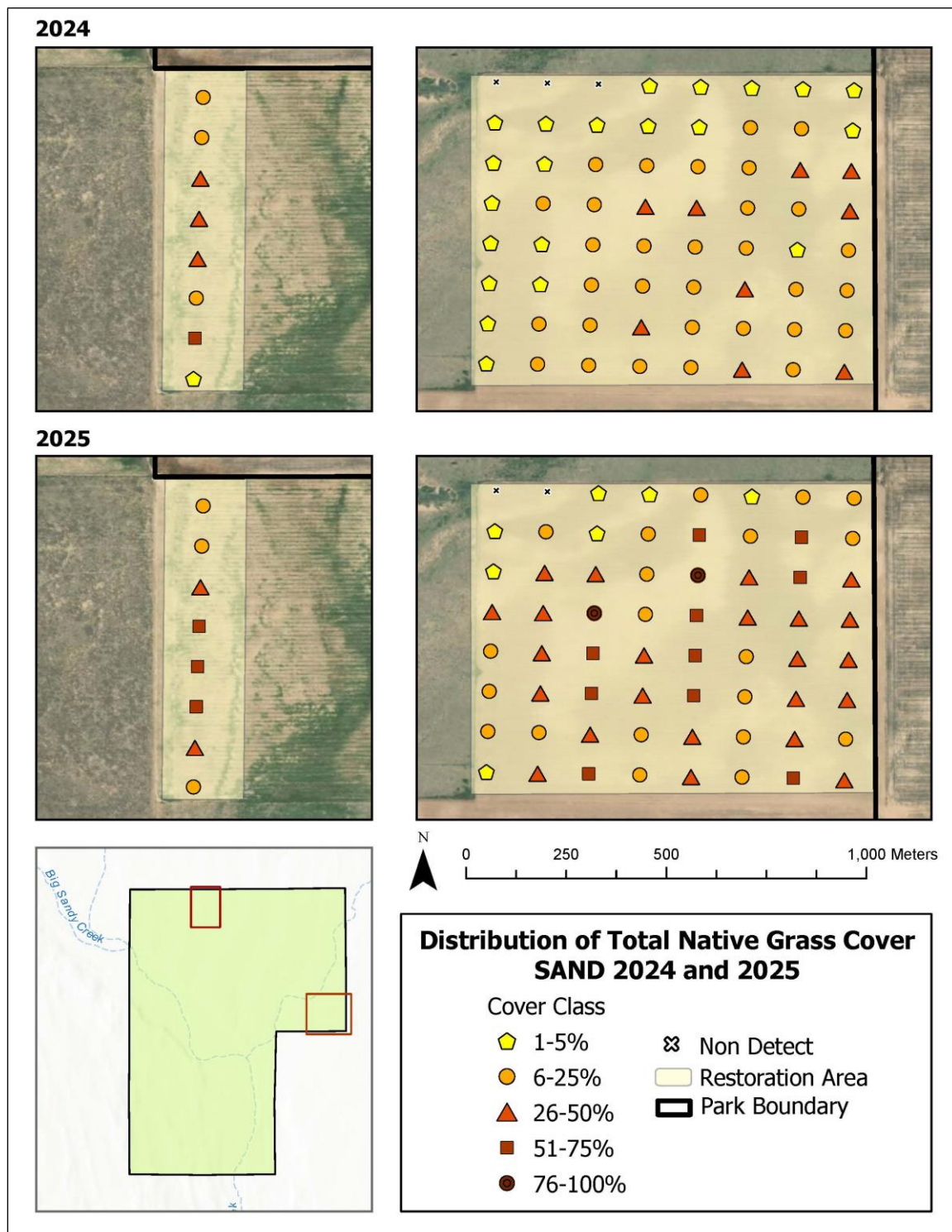
This report received peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information. Peer review helps to ensure that the 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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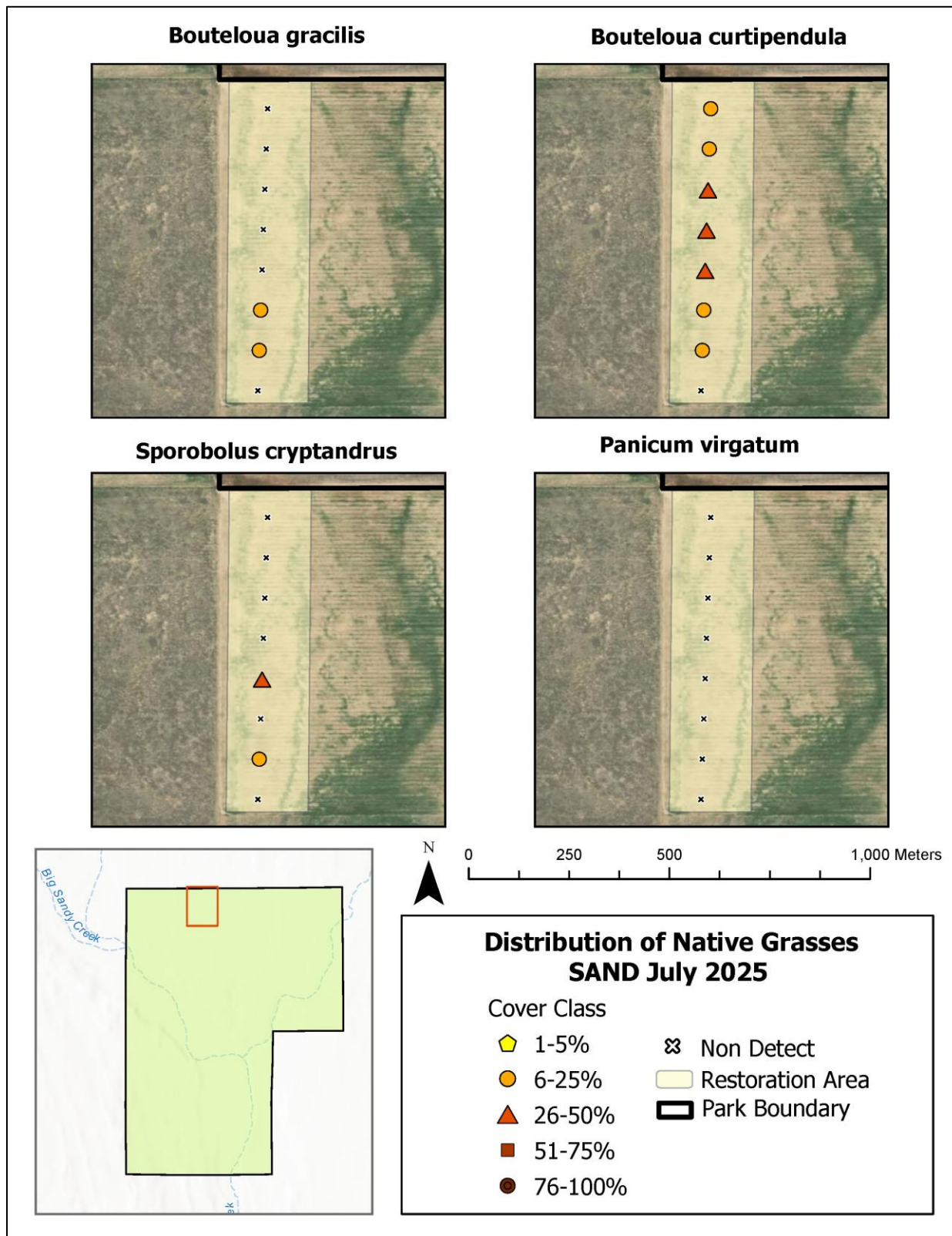
- Owen, M., S. Hedberg, and E. Fitzpatrick. 2025. Sand Creek Massacre National Historic Site Revegetation Monitoring Summary—2025. National Park Service, Southern Plains Inventory and Monitoring Network, Pecos, New Mexico.

Appendix A. Sand Creek Massacre National Historic Site Revegetation Monitoring Survey Maps, 2025

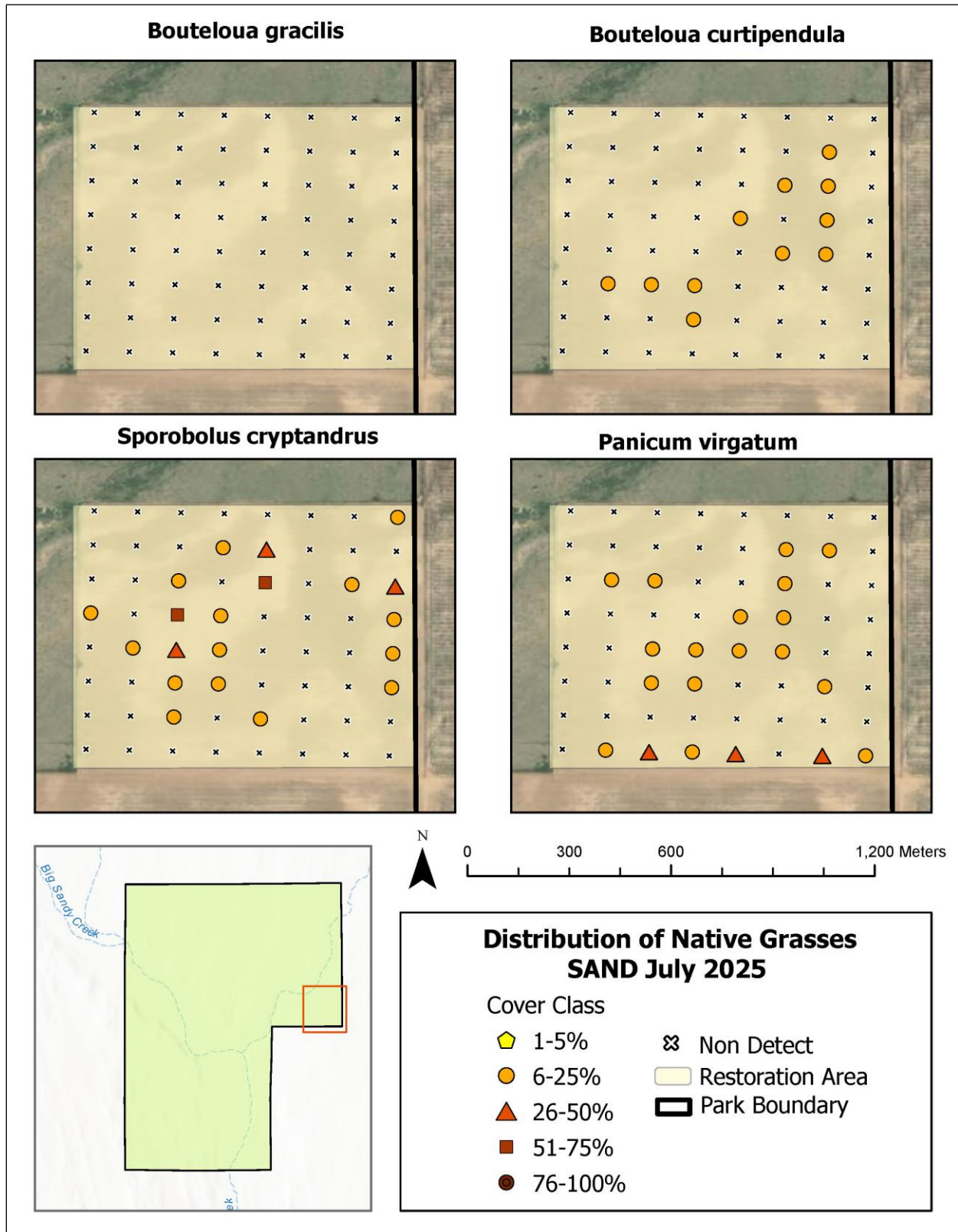
Map A-1. Total native grass distribution and canopy cover recorded in July 2024 and 2025 surveys. Section 18 is on the left, and Section 20 is on the right. NPS figure



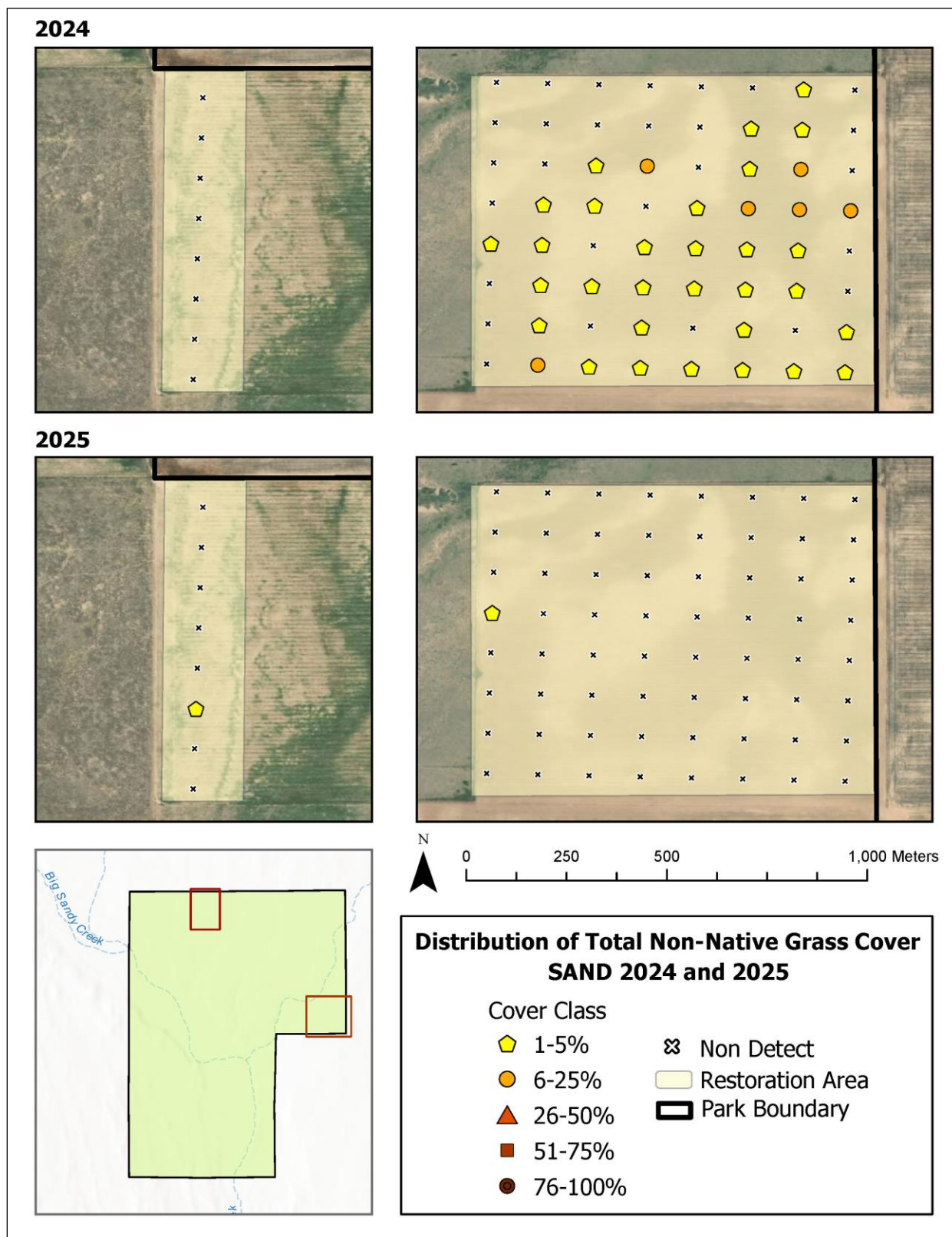
Map A-2. Native grass distribution and canopy cover by species, recorded in Section 18 in July 2025. Species shown are blue grama (*Bouteloua gracilis*), sideoats grama (*Bouteloua curtipendula*), sand dropseed (*Sporobolus cryptandrus*), and switchgrass (*Panicum virgatum*). NPS figure



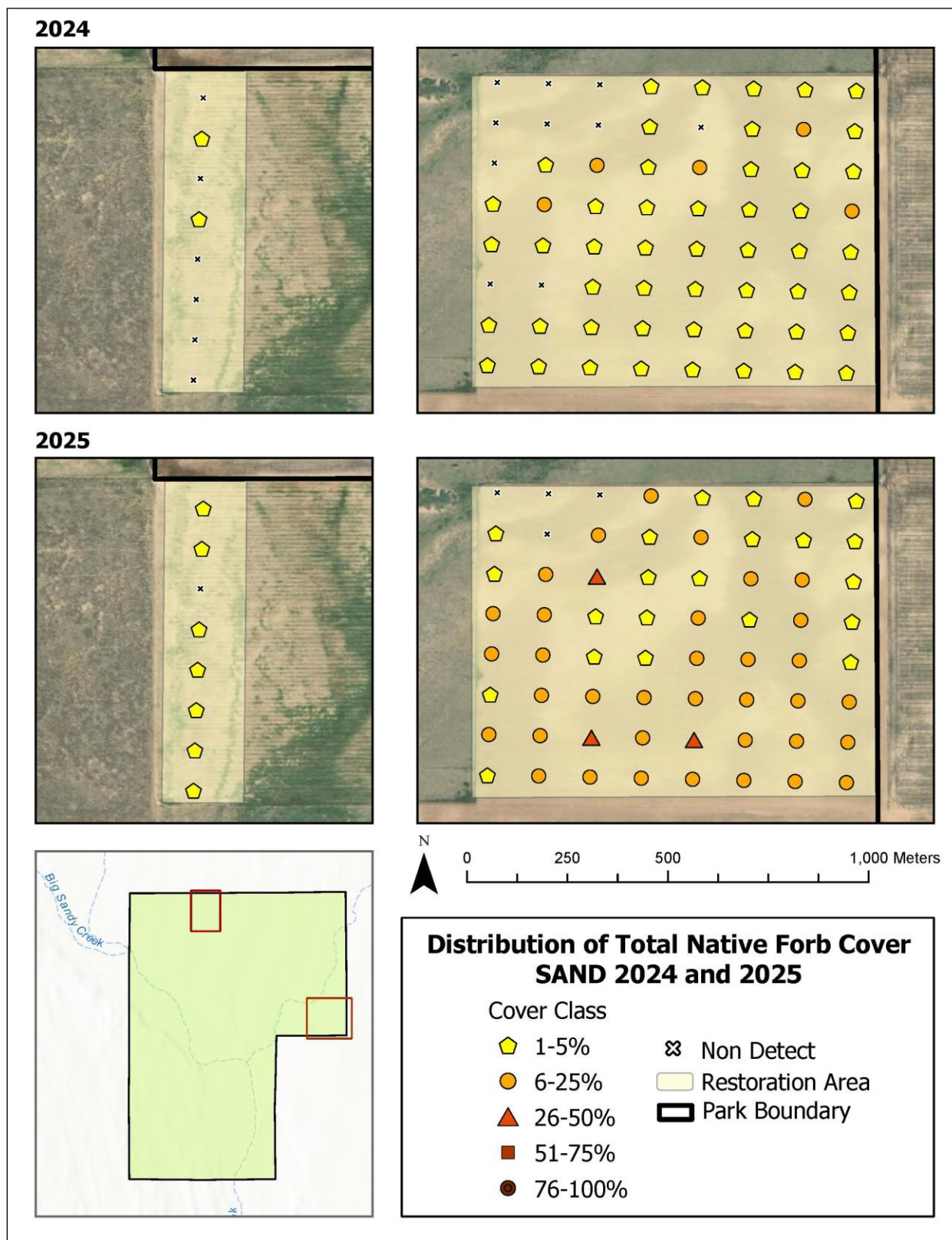
Map A-3. Native grass distribution and canopy cover by species, recorded in Section 20 in July 2025. Species shown are blue grama (*Bouteloua gracilis*), sideoats grama (*Bouteloua curtipendula*), sand dropseed (*Sporobolus cryptandrus*), and switchgrass (*Panicum virgatum*). NPS figure



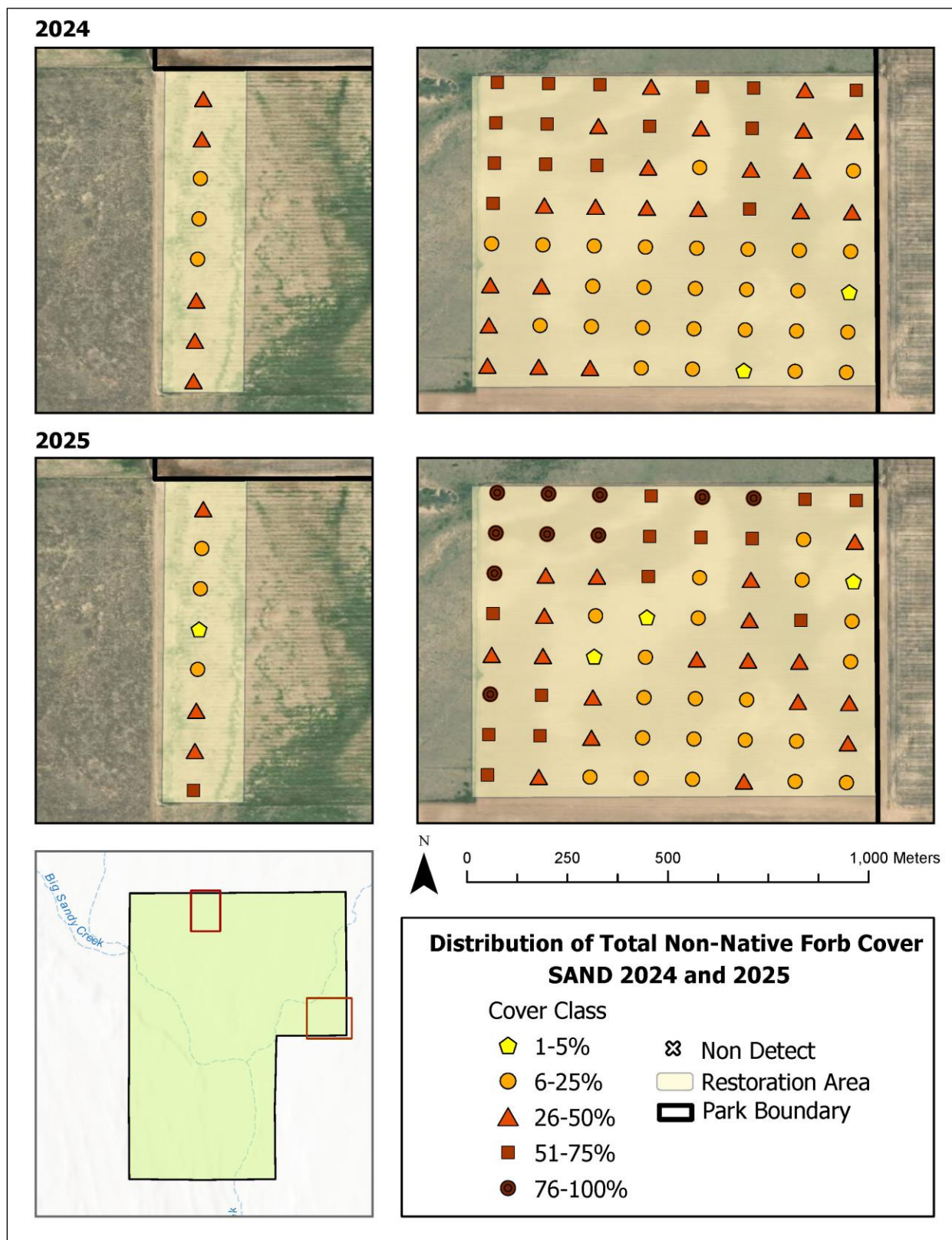
Map A-4. Total non-native grass distribution and canopy cover recorded in July 2024 and 2025 surveys. Section 18 is on the left, and Section 20 is on the right. NPS figure



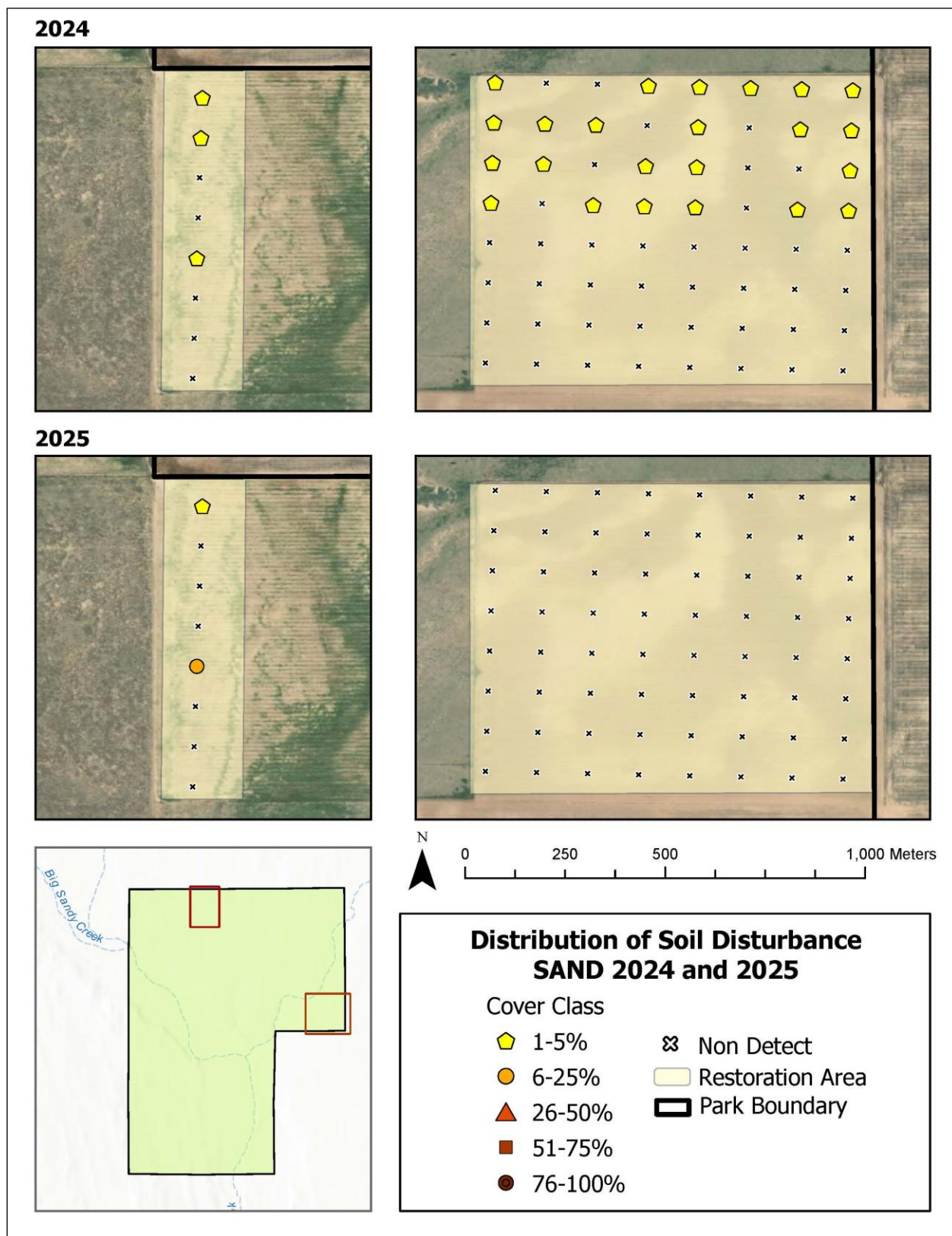
Map A-5. Total native forb distribution and canopy cover recorded in July 2024 and 2025 surveys. Section 18 is on the left, and Section 20 is on the right. NPS figure



Map A-6. Total non-native forb distribution and canopy cover recorded in July 2024 and 2025 surveys. Section 18 is on the left, and Section 20 is on the right. NPS figure



Map A-7. Soil disturbance distribution and cover recorded in July 2024 and 2025 surveys. Section 18 is on the left, and Section 20 is on the right. NPS figure



Map A-8. Bare soil distribution and cover recorded in July 2024 and 2025 surveys. Section 18 is on the left, and Section 20 is on the right. NPS figure

