

Noxious Weed Mapping, Monitoring, & Treatment at the U.S. Air Force Academy, Year 21



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COLORADO STATE UNIVERSITY

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Colorado Natural Heritage Program at Colorado State University

March 25, 2026



**WARNER COLLEGE OF
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CNHP's mission is to advance the conservation of Colorado's native species and ecosystems through science, planning, and education for the benefit of current and future generations.

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Front Cover:
Jack's Valley East in 2025 at the U.S. Air Force Academy – Photo by Robert Monahan

EXECUTIVE SUMMARY

This report summarizes the results of population monitoring of noxious weeds over the last twenty-one years at the U.S. Air Force Academy (“the Academy”) and at the Farish Recreation Area (“Farish”). The Colorado Natural Heritage Program has conducted basewide weed mapping at the Academy roughly every five-years, starting in 2002. Since then, basewide mapping has been done in 2007, 2012, 2018, and 2024 with follow-up mapping occurring in 2025. Basewide weed mapping has been conducted at the Farish in 2002, 2007, 2012, 2017, and 2025. In between basewide mapping years, areal mapping at known sites was conducted at the Academy for species with low cover. Additionally, permanent plots were monitored for widespread species from 2005 to 2018. There was no monitoring in 2022. The 2025 monitoring effort included eighteen species, which receive yearly areal mapping and treatments. The majority of monitored sites were treated manually following species specific manual weed treatment protocols. These treated sites received follow-up visits for monitoring and additional treatments, as necessary. Sites were visited from 1-3 times depending on the species threat level and monitoring results.

Fifteen of the eighteen low cover noxious weeds species at the Academy were prioritized for manual treatments by the Colorado Natural Heritage Program in 2025 (Tatarian honeysuckle, Morrow’s honeysuckle, and salt cedar are treated by the Academy staff). The monitoring strategy which has been used for the past six years was first conceived after the 2018 basewide survey and has been implemented since the summer of 2019. The results of the basewide survey in 2018 showed increases in weeds so a strategy was developed to reduce species that have a reasonable chance of being eradicated, contained, or suppressed with manual treatments. One of the methods used to make treatments more successful was to conduct multiple visits to sites with extant occurrences throughout the same growing season. This strategy, implemented in 2019, is utilized for species considered to have low cover and high potential for control or eradication across the Academy. After six years of implementing this strategy, it is showing promising results for some species such as myrtle spurge, perennial pepperweed, and Russian knapweed.

Summary of Findings

As part of the manual treatments in 2025, there were a total of 1,071 site visits with 30,436 individuals mapped and 11,680 shoots removed (Table 1). Two species of noxious weeds at the Academy are showing decreasing trends since 2024 (green arrows): Oxeye daisy and bouncing bet; Five species are stable with less than 10% change (yellow diamonds), including houndstongue, yellow spring bedstraw, dame's rocket, common St. John's wort, and Tatarian honeysuckle; Four species are showing moderate increases of less than 100% change (orange arrows), including garlic mustard, Dalmatian toadflax, Russian knapweed, and salt cedar; Five species are increasing rapidly since 2024 (>100% change red arrow), which includes myrtle spurge, orange hawkweed, Scotch thistle, perennial pepperweed, and common tansy. It is not known what the trends are for scentless chamomile and Morrow's honeysuckle because there is not sufficient data at this time (question marks) (Table 1). For more details, see individual species sections.

Table 1. Summary of treatments for noxious weeds monitored at the Academy in 2025.

Change '24-'25	Scientific Name	Common Name	#CNHP Site Visits	Total # Shoots	# Shoots Treated
	<i>Alliaria petiolata</i>	garlic mustard	12	9,454	754
	<i>Cynoglossum officinale</i>	houndstongue	125	4,323	2,216
	<i>Euphorbia myrsinites</i>	myrtle spurge	136	257	255
	<i>Galium verum</i>	yellow spring bedstraw	3	43	43
	<i>Hesperis matronalis</i>	dame's rocket	4	1	1
	<i>Hieracium aurantiacum</i>	orange hawkweed	1	39	39
	<i>Hypericum perforatum</i>	common St. John's wort	81	5,177	2,621
	<i>Lepidium latifolium</i>	perennial pepperweed	6	187	187
	<i>Leucanthemum vulgare</i>	oxeye daisy	2	0	0
	<i>Linaria dalmatica</i>	Dalmatian toadflax	5	12	12
	<i>Lonicera morrowii</i>	Morrow's honeysuckle	0	0	0
	<i>Lonicera tatarica</i>	Tatarian honeysuckle	70	504	0
	<i>Onopordum acanthium</i>	Scotch thistle	460	6,005	3,106
	<i>Rhaponticum repens</i>	Russian knapweed	23	117	117
	<i>Saponaria officinalis</i>	bouncingbet	53	2,395	570
	<i>Tamarix ramosissima</i>	salt cedar	2	2	0
	<i>Tanacetum vulgare</i>	common tansy	4	420	420
	<i>Tripleurospermum inodorum</i>	scentless chamomile	84	1,472	1,307
TOTALS			1,071	30,408	11,646

Summary of Recommendations

- Monitor and treat all known sites of Russian knapweed, myrtle spurge, dame's rocket, orange hawkweed, perennial pepperweed, oxeye daisy, Dalmatian toadflax, and common tansy, multiple times during the growing season.
- Continue to monitor and treat high priority sites of Scotch thistle and houndstongue in the spring and summer. Sites in dense vegetation are low priorities for treatment for biennials, based on data that suggests leaving them in situ can result in natural reductions.
- Identify sites that should be avoided for treatments that have the potential to recover over time (Scotch thistle, houndstongue).
- Continue to coordinate treatment activities with resource management staff, herbicide contractor and CNHP to target areas of concern (rapid response). Provide the applicator with maps of rare species and wetland areas to help avoid impacts to rare plant and animal species during the season, as needed.
- Treat sprouts throughout the growing season at treatment sites, as this stage is the easiest, least destructive to the soils, and most effective way to provide control and prevent seed production.
- Continue to monitor populations of bouncingbet and remove flowering stems.
- Recommendations for the use of monitoring plots at the Academy and Farish are under discussion for future monitoring efforts.
- Noxious weed species of management concern (Colorado Department of Agriculture, 2025) which need rapid response actions include:
 - o Myrtle spurge (List A)
 - o Orange hawkweed (List A)
 - o Perennial pepperweed (List B)
 - o Russian knapweed (List B)
 - o Oxeye daisy (List B)
 - o Scotch thistle (List B)
 - o Houndstongue (List B)
 - o Salt cedar (List B)
 - o Dalmatian toadflax (List B)
 - o Dame's rocket (List B)
 - o Common tansy (List B)

- o Scentless chamomile (List B)
- o Bouncingbet (List B)
- o Common St. John's wort (List C)
- o Garlic mustard (State Watch List)
- o Yellow spring bedstraw (not listed, garden escape)
- o Tatarian honeysuckle (not listed, garden escape)
- o Morrow's honeysuckle (not listed, garden escape)

Noxious weeds with a high potential of being found at the Academy and Farish include:

- o Purple loosestrife – potentially present at the Academy (List A)
- o Hairy willowherb – known from an adjacent county (List A)
- o Tansy ragwort – documented in Colorado Springs (List A)
- o Dyer's woad – documented just north of the base (List A)
- o Rush skeletonweed – documented in the vicinity (List A)
- o Mediterranean sage – known from an adjacent county (List A)
- o Japanese knotweed – documented north of Castle Rock (List A)
- o Plumeless thistle – documented north of Larkspur (List B)
- o Cutleaf teasel – documented in Colorado Springs (List B)
- o Eurasian watermilfoil – documented in the vicinity (List B)
- o Sulfur cinquefoil – documented in Colorado Springs (List B)
- o Absinth wormwood – documented in El Paso County (List B)
- o Wild caraway – documented in Woodland Park (List B)
- o Jointed goatgrass – documented in El Paso County (List B)

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INTRODUCTION

An Integrated Natural Resources Management Plan (Smith et al., 2015) has been developed for the U.S. Air Force Academy and the Air Force Civil Engineer Center in accordance with Air Force Manual AFMAN 32-7003, Environmental Conservation; Air Force Policy Directive 32-70, Environmental Quality; and the provisions of the Sikes Act, as amended (Cooperative Plan for Conservation and Rehabilitation, Title 16 U.S. Code § 670a, 1997). DAFMAN32-7003 requires the control of noxious, exotic, and invasive species (Chaudhary, 2024). The INRMP was updated in 2023 (U.S. Fish & Wildlife Service et al., 2023). The Academy issued a Finding of No Significant Impact for the INRMP's Environmental Assessment, which included an analysis of noxious weed control objectives and actions. Noxious weed control is also a conservation strategy identified in the Preble's meadow jumping mouse Conservation Plan, which is supported by a USFWS Biological Opinion (U.S. Fish & Wildlife Service, 2020).

Many local governments now require public and private landowners to manage noxious weeds. The U.S. Air Force Academy (referred to herein as "the Academy") follows state (Colorado Department of Agriculture) and county (El Paso County) weed control regulations for noxious weeds (Conservation Services Division, 2026). The Academy has also established management objectives for weed control in order to remain consistent with local weed regulations (Smith et al. 2015; U.S. Fish & Wildlife Service et al., 2023). The Academy is located near Colorado Springs, Colorado (Map 1).

The management objectives are defined as specific, desired results of integrated management efforts and include the following definitions:

- **Eradication**: Reducing the reproductive success of a noxious weed species in a largely uninfested region to zero and permanently eliminating the species or population within a specified period of time (until the existing seed bank is exhausted).
- **Containment**: Maintaining an intensively managed buffer zone that separates infested regions, where suppression activities prevail, from largely uninfested regions, where eradication activities prevail.
- **Suppression**: Reducing the vigor of noxious weed populations within an infested region, decreasing the propensity of noxious weed species to spread to surrounding lands, and mitigating the negative effects of noxious weed populations on infested lands.

A sizable portion of the landscape at the Academy and the Farish Recreation Area falls into the “natural areas” category and includes important wetland features. The Academy and Farish are important for local and global biodiversity conservation (Schorr & Smith, 2019; Siemers et al., 2012). At least thirty-five plants, animals, and plant communities of conservation concern have been documented at the Academy and Farish (Colorado Natural Heritage Program, 2026). For example, Porter’s feathergrass (*Ptilagrostis porteri*), a globally imperiled endemic of Colorado, and Southern Rocky Mountain cinquefoil (*Potentilla ambigens*), found only in Colorado and New Mexico (Schorr & Smith, 2019; Siemers et al., 2012), have been documented on-site. In addition, the Academy is critically important for the conservation of the listed Threatened Preble’s meadow jumping mouse (*Zapus hudsonius preblei*) (Schorr & Smith, 2019; Siemers et al., 2012).

Herbicide Use in Natural Communities

Guidelines for controlling noxious weeds (including herbicide label instructions) are often based on agricultural landscapes instead of natural plant communities or wildlands. There is a large distinction between these two land uses, especially for weed management, which was addressed in the 2015 update to the Noxious Weed Management Plan (Smith et al., 2015). Natural areas can be defined as non-crop areas that support native vegetation, and where management includes the protection of these areas as well as the generation of ecosystem services (Pearson & Ortega, 2009). These areas were delineated at the Academy as Special Weed Management Areas (Smith et al., 2015; Figure 1). To successfully manage weeds in natural areas with high biodiversity is much more complex than in an agricultural area. Successful weed management in natural areas must also consider the management of the entire community. The presence of rare plants, pollinators, and wildlife, including a federally threatened mammal species (Preble’s Meadow Jumping Mouse) that lives in riparian areas at the Academy, needs consideration. Although many herbicides are tested for toxicity to animals to some degree, the adjuvants often added to herbicides and the mixtures of herbicides used by contractors are not (Wagner et al., 2017).

Weed infestations are most often the result of previous land disturbances, therefore, the primary goal in weed management in natural communities is to prevent or minimize disturbances to soil and native plants. Herbicides can cause soil disturbances by harming soil organisms, changing soil chemistry and killing surrounding plant species and are considered a last resort by numerous wildland managers (Boulder County Parks & Open Space, 2024; El Paso County Parks &

Community Services, 2024; The Nature Conservancy, 2011; Tu et al, 2001; Wagner et al., 2017).

The efficacy of herbicide treatments has not been well-documented in North America. There is scientific literature on the efficacy of herbicides for controlling target weeds but most of this research focuses exclusively on the target plant with no information on the desirable native plant species, and the outcomes are only monitored over a brief period of time, neglecting the economic impacts of management actions (Wagner et al., 2017). The research suggests herbicides alone are not effective in the long-term and typically result in re-infestations of the same or different noxious weeds species (Pearson et al., 2016, Peterson et al., 2020). Careful consideration needs to be made by land managers to consider if an herbicide will do more conservation good than harm in each situation (Tu et al., 2001). This is the basis for the following herbicide application guidelines in natural communities at the Academy.

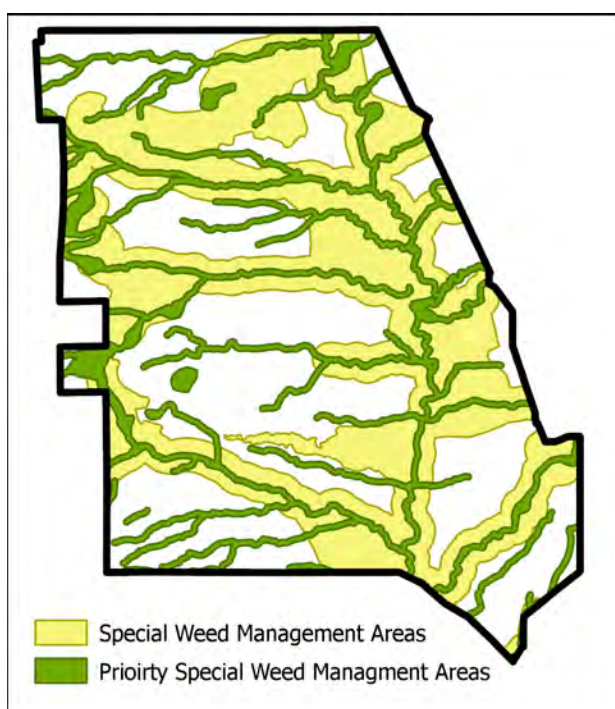


Figure 1. Special Weed Management Areas at the Academy.

Guidelines for Herbicide Use in Natural Areas

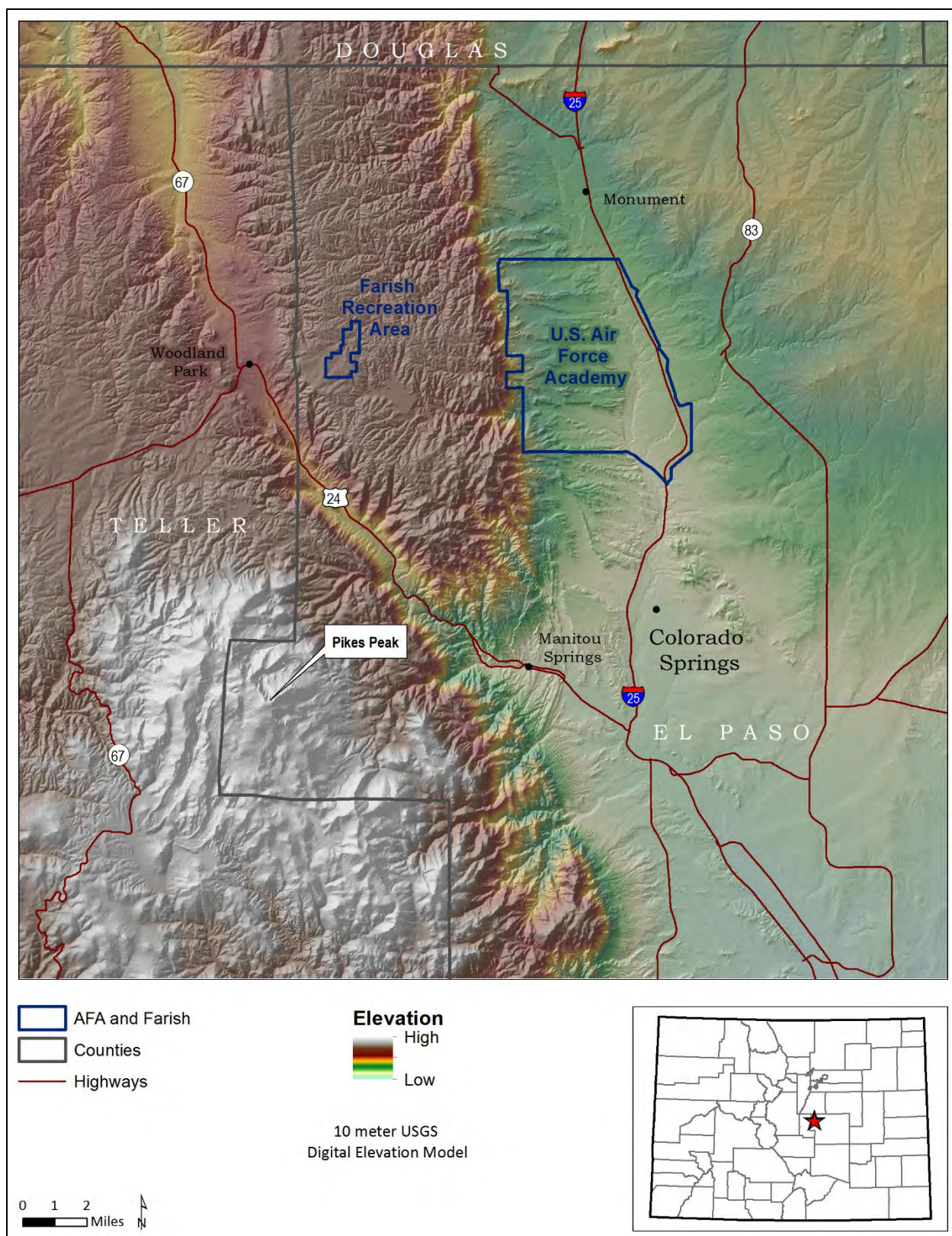
- 1) If other methods (manual removal, biocontrol) are available, those should be used first. Herbicides should be used as a last resort and when all other reasonable alternatives have been ruled out in natural plant communities (Boulder County Parks & Open Space, 2024; El Paso County Parks &

Community Services, 2024; The Nature Conservancy, 2011; Tu et al., 2001; Wagner et al., 2017).

- 2) Consider potential impacts of treatment to determine if there will be more impacts from treating than not treating (Boulder County Parks & Open Space, 2024; The Nature Conservancy, 2011; Tu et al., 2001; Wagner et al., 2017).
- 3) Spot applications of herbicide that target individual plants by either wiping herbicide with a wicking cloth or a precise spray that is aimed at the target plant minimizing harm to adjacent plants and soils is highly recommended by numerous land conservation agencies (Boulder County Parks & Open Space, 2024; Great Pond Mountain Conservation Trust, 2019; The Nature Conservancy, 2011; Tu et al., 2001; Wagner et al., 2017).
- 4) Consider herbicides that are selective for broadleaf weed species to protect native grasses, which are effective against the target species. The Special Management Areas are not rangelands. Recommended dosing and application methods for rangelands can damage natural resources and harm wildlife. Follow label instructions for wildlands and wetlands. Using herbicides in areas with Preble's Meadow Jumping Mice and rare plant species is not recommended.
- 5) Time herbicide application to the susceptible life stage and to minimize seed production. Avoid spraying bolted thistles in late stages and mid-summer application of herbicides which are less effective, require larger amounts of herbicide and result in greater off-target damage.
- 6) Consider not treating species which have active biocontrol agents.
- 7) Document all herbicide applications.
- 8) Follow-up monitoring of treated sites to measure effectiveness and to catch late season sprouts.
- 9) Adaptive management flexibility to change a course of action if a certain method is unsuccessful or needs adjustment.
- 10) Use an integrated approach to treatments. Chemical treatments alone are almost never successful and are used as a part of an integrated control program, when necessary, in wildlands.

Reasonable Goals to Reduce Weed Cover at the Academy

- 1) All activities that prevent the spread of noxious weeds across the Academy, including avoiding disturbance of natural lands, and cleaning equipment are considered most effective, i.e., prevention. (Wagner et al., 2017)
- 2) Focus on mapping, monitoring and treatments for rapid response species that have less widespread cover (Wagner et al., 2017).
- 3) Utilize biocontrol agents, when available, for species that have widespread cover.
- 4) Staff and contractors can be on the lookout for new infestations as weed monitoring and management activities occur in between five-year basewide monitoring efforts.
- 5) Avoid treating large areas with dense infestations of widespread weed species without a restoration plan. Treating satellite populations or edges may help contain some noxious weeds.
- 6) See individual species recommendations for specific details.



Timeline of Weed Mapping and Monitoring at the Academy

The Colorado Natural Heritage Program first mapped noxious weeds at the Academy and Farish in 2002 and has monitored noxious weeds at the Academy for the past 23 years. Below is a summary of weed mapping and monitoring by year since the surveys began in 2002. Refer to Appendix A for monitoring and mapping activities by species.

- **2002:** Approximately 3,900 weed locations were mapped at the Academy and Farish, with fourteen species on the target list (Anderson et al., 2003).
- **2003:** Hoary cress (*Lepidium draba*) and Russian olive (*Elaeagnus angustifolia*) were remapped in 2003. In 2002, severe drought conditions suppressed the distribution of these two species. In 2003, populations increased due to ample spring moisture which necessitated a second year of mapping.
- **2004:** Based on data from the weed mapping conducted in 2002–2003, an integrated noxious weed management plan was developed which supports the 2004 *Integrated Natural Resources Management Plan* (Carpenter et al., 2004) for the Academy, which was updated most recently in 2023 (U.S Fish & Wildlife Service et al., 2023). The first report of Russian knapweed (*Rhaponticum repens*) was submitted.
- **2005:** A monitoring program was established for thirteen species of noxious weeds using a combination of permanent monitoring plots and areal mapping. Natural Resource staff at the Academy reported occurrences of myrtle spurge (*Euphorbia myrsinites*), a List A noxious weed. It was also noted that diffuse and spotted knapweeds were hybridizing at the Academy.
- **2006:** Permanent monitoring plots established in 2005 were re-sampled. All infestations of spotted knapweed and Russian knapweed were revisited and mapped. Myrtle spurge was added to the target weed list for mapping and assessment.
- **2007:** The second basewide noxious weed survey of the Academy and Farish was completed, with a total of seventeen mapped species at approximately 5,500 locations (Anderson and Lavender, 2008).
- **2008:** Based on previous year's data, protocols were adjusted for the 2008 surveys. Tatarian honeysuckle (*Lonicera tatarica*) was discovered at the Academy.

- **2009:** A total of fourteen species were targeted for monitoring. Two additional species were mapped: houndstongue (*Cynoglossum officinale*) and Dalmatian toadflax (*Linaria dalmatica*). Yellow toadflax (*Linaria vulgaris*) was removed from monitoring due to its abundance. A habitat suitability model for spotted knapweed was produced.
- **2010:** Yellow spring bedstraw (*Galium verum*) was discovered at the Academy and mapped. Diffuse knapweed (*Centaurea diffusa*) was not monitored.
- **2011:** Updated monitoring protocols were employed. The annual mapping of Tatarian honeysuckle began. Diffuse knapweed and hoary cress (*Lepidium draba*) were not monitored.
- **2012:** Collaboration with United States Fish & Wildlife Service (USFWS) and Texas A&M AgriLife Research Biocontrol Program resulted in the following modifications: 1) CNHP and Texas A&M began using the same monitoring program for the plot surveys; 2) CNHP took over the monitoring and management responsibilities for leafy spurge (*Euphorbia virgata*) and common St. John's wort (*Hypericum perforatum*); 3) biocontrol plots (Texas A&M) for Canada thistle (*Cirsium arvense*) and diffuse knapweed (*Centaurea diffusa*) were compared to non-biocontrol plots (CNHP); 4) permanent plots were established for hoary cress (*Lepidium draba*) and leafy spurge (*Euphorbia virgata*); and 5) the third basewide weed survey for the Academy and Farish was completed, mapping 22 weed species and an estimated 39% increase in area occupied (Lavender-Greenwell and Rondeau, 2013).
- **2013:** Monitoring was the same as in 2012, except that Farish was not visited, and Canada thistle and dame's rocket were not monitored. Diffuse knapweed and spotted knapweed hybridization was widespread. The two knapweed species (*Centaurea stoebe* ssp. *micranthos*, *C. diffusa*) and the hybrid knapweed were lumped together for plot results.
- **2014:** Monitoring was the same as in 2013, except that hoary cress (*Lepidium draba*) plots were not visited, and Canada thistle plots were visited. Dame's rocket was mapped too late in the season to report trends. Hoary cress and dame's rocket were prioritized for 2015.
- **2015:** Monitoring was the same as in 2014, except that hoary cress (*Lepidium draba*) plots were monitored, and three new plots were established. In addition, five biocontrol plots were re-visited (and re-established) for

knapweeds and a new Canada thistle plot was established. One Canada thistle monitoring plot was not visited because it was under water for most of the summer. One diffuse knapweed plot was removed from monitoring because it has been incorporated into a golf course. Five plots had rare plant or animal species located within them. A large population of a globally vulnerable, state imperiled species, the Rocky Mountain cinquefoil (*Potentilla ambigens*) was destroyed by recent flooding.

- **2016:** Monitoring at all permanent monitoring plots at the Academy (41 plots) and Farish (30 plots) with a minimum of ten plots for each species for 2016. Census monitoring was conducted at 412 out of 464 known sites. A List B noxious weed was collected in Kettle Creek, scentless chamomile (*Tripleurospermum inodorum*), which was new for the Academy and a new record for El Paso County. A specimen was deposited at the Charles Maurer Herbarium at Colorado State University.
- **2017:** Monitoring at 42 plots (all plots except hoary cress); all stable to decreasing trends; 236 out of a total of 468 areal weed sites visited (49%) had weeds present in 2017. Scentless chamomile was found in Kettle Creek for a second year. A fourth comprehensive weed map was completed for Farish with a total of four mapped species at approximately 477 extant locations.
- **2018:** The fourth basewide noxious weed survey of the Academy was completed, with a total of twenty-five mapped species at over 9,300 extant locations at the Academy. Forty-five permanent plots were monitored for five species: Canada thistle (8 plots), hoary cress (10 plots), leafy spurge (10 plots), knapweeds (7 plots) and musk thistle (10 photo plots). Three detailed site plans were written for weed treatments in areas with plants and animals of conservation concern. A new List A noxious weed species, orange hawkweed (*Hieracium aurantiacum*), was discovered in 2018 at Farish.
- **2019:** Fifteen noxious weed species were prioritized for manual treatments by CNHP for the first time. The strategy to include multiple visits within the same growing season to treat sprouts is expected to yield reductions for 2020. Surveying West Monument Creek for garlic mustard was added to the tasks. A new list B species, oxeye daisy (*Leucanthemum vulgare*), was added to the noxious weed list at the Academy.

- **2020:** 17 species were monitored, and sixteen noxious weed species were prioritized for manual treatments by CNHP for the second year. A new list B species, common tansy (*Tanacetum vulgare*), was mapped in 2020.
- **2021:** 17 species were monitored with fifteen noxious weeds prioritized for manual treatments by CNHP for the third year.
- **2022:** No monitoring was done in 2022.
- **2023:** 17 species were monitored with fifteen noxious weeds prioritized for manual treatments by CNHP for the fourth year. Hoary alyssum (*Berteroa incana*), a Colorado Watch List species, was mapped for the first time in 2023, although it has been previously found at the Academy. Hoary alyssum was added to the basewide weed mapping list for 2024.
- **2024:** The fifth basewide noxious weed survey of the Academy was undertaken in 2024, with a total of thirty-one species mapped at over 9,615 extant locations within the Academy. Fifteen noxious weeds were prioritized for manual treatments by CNHP for the fifth year. Marrow's honeysuckle (*Lonicera morrowii*) and bladder campion (*Silene latifolia*) were mapped for the first time in 2024.
- **2025:** Follow up mapping to 2024 basewide survey was completed for the thirty-one noxious species known to occur at the Academy in target areas. Seventeen species were monitored with fifteen noxious weeds prioritized for manual treatments by CNHP. All noxious weed species were mapped across the Farish Recreation Area at 718 extant locations. There continues to be only four noxious species known within the Farish Recreation Area.

METHODS

The objective of this project is to identify trends and evaluate the effectiveness of ongoing management of noxious weeds at the Academy. Since 2002, four types of monitoring have been utilized to measure the changes in noxious weed cover, density, and distribution at the Academy and Farish.

- **Basewide weed mapping** includes visiting all known occurrences and surveying for new occurrences and new noxious weed species. This is the most intensive survey, and it is conducted once every five years (a complete census of targeted species).
- **Annual Monitoring** occurs in between the basewide mapping years and is conducted by re-visiting the known occurrences of rapid response species or those with limited distributions.
- **Permanent plot monitoring** is used to determine trends for the most widespread species. At the Academy, five species have been targeted for permanent plots: Canada thistle, leafy spurge, hoary cress, knapweeds (spotted, diffuse and hybrids) and musk thistle. Photo plots are used to monitor musk thistle while a transect survey sampling method is used on the other four species. Plot monitoring was suspended in 2019.
- **Monitoring with treatments** was added in 2019 as a method to address weed increases for rapid response species. This new method combines areal mapping with treatments and includes multiple visits to sites that had plants at the initial monitoring visit to look for sprouts.

The original recommendations for the design and deployment of monitoring plots offered by Carpenter et al. (2004) were used, and subsequently modified as new information was collected. The long-term monitoring plots were suspended in 2019 to allow time for more focus on the targeted monitoring and manual treatments that were implemented in 2019.

Basewide weed mapping in 2024 at the Air Force Academy and in 2025 at the Farish Recreation Area was performed using a census survey method where weeds were documented by walking the property using GPS and GIS technology. Infestations were mapped as points, lines, or polygons, depending on the size and shape of each occurrence. Points and lines were buffered to estimate actual size. Irregularly shaped features greater than approximately thirty meters in any direction

were mapped as polygons. Data were mapped using an iPad Pro tablet with a Bad Elf Flex Mini GPS receiver and Esri Field Maps, a portable version of Geographic Information Systems (GIS) software. Qualitative notes and actual counts or estimates for populations were made at each mapping site. A more detailed description of the mapping protocol is provided in Appendix B. The next base wide weed mapping will be targeted for 2029.

Biocontrol introductions by Texas A&M AgriLife were discontinued in 2015 since most of the populations of weeds at the Academy were determined to be too small to support biocontrol agents. However, some of the noxious weed populations may grow to the point of being able to support biocontrol agents, so monitoring for these agents should continue to be a part of the survey. Weed surveyors photographed and took notes on any biocontrol or potential biocontrol agents observed at survey sites. In addition, grazing by insects and animals was noted when observed. Common St. John's wort, Canada thistle, musk thistle, bouncingbet, and leafy spurge are showing signs of significant impacts from biocontrol organisms and wildlife. The timing of weed treatments is one of the most critical factors in effective weed control. Many of the species sprout, bloom, and go to seed at various times throughout the growing season. A treatment schedule was created to provide the timing as well as the types of treatments. To be able to conduct the treatments and make multiple visits to sites, the long-term monitoring plots were not monitored in 2019–2025 (Table 3). The decision to manually treat plants was made by the field team on a site-by-site basis, looking at the treatment necessary, number of individuals at the site, location, previous herbicide application or the presence of biocontrol, and the biomass that needed to be removed.

The changes and modification that began in 2019 are part of an adaptive management action. These changes are to be made when it is clear current management strategies are not effective or new information on treatments have become available as specified in the Academy's Integrated Noxious Weed Management Plan (Carpenter et al., 2004) as modified by Anderson and Lavender-Greenwell (2008), and Smith et al. (2015).

Table 2. Description of weed treatment methods for 2025.

Type	Description of Actions
Manual #1	Sever below crown with knife pre-flower or rosette; revisit before fall all sites that had plants.
Manual #2	Pull entire root pre-flower; revisit all sites in fall that had plants; for hawkweed, be careful to remove ALL root fragments (as much as possible)
Method #3 flagging	Flag for herbicide application – spot treatment (dates and herbicide recommendations may be discussed with applicator in spring meeting)

Table 3. Summary of weed treatment methods and actions for 2025.

Latin Name	Common Name	2025 Methods/Actions	2025 Action
<i>Alliaria petiolata</i>	garlic mustard	Areal/Treatment	Manual #2 & 3
<i>Caragana arborescens</i>	Siberian peashrub	Areal	---
<i>Carduus nutans</i>	musk thistle	Areal	---
<i>Centaurea diffusa</i>	diffuse knapweed	Areal	---
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	spotted knapweed	Areal	---
<i>Centaurea x psammogena</i>	hybrid knapweed	Areal	---
<i>Cirsium arvense</i>	Canada thistle	Areal	---
<i>Cirsium vulgare</i>	bull thistle	Areal	---
<i>Cynoglossum officinale</i>	houndstongue	Areal/Treatment	Manual #1
<i>Dipsacus fullonum</i>	common teasel	Areal	---
<i>Elaeagnus angustifolia</i>	Russian olive	Areal	---
<i>Euphorbia virgata</i>	leafy spurge	Areal	---
<i>Euphorbia myrsinites</i>	myrtle spurge	Areal/Treatment	Manual #2
<i>Galium verum</i>	yellow spring bedstraw	Areal/Treatment	Manual #2
<i>Hesperis matronalis</i>	dame's rocket	Areal/Treatment	Manual #1
<i>Hieracium aurantiacum</i>	orange hawkweed	Areal/Treatment	Manual #1 & 2
<i>Hypericum perforatum</i>	common St. John's wort	Areal/ Partial Treatment	Manual #2 (< 100 plants)
<i>Lepidium draba</i>	hoary cress	Areal	---
<i>Lepidium latifolium</i>	perennial pepperweed	Areal/Treatment	Manual #1 / Manual #3
<i>Leucanthemum vulgare</i>	oxeye daisy	Areal/Treatment	Manual #2
<i>Linaria dalmatica</i>	Dalmatian toadflax	Areal/Treatment	Manual #2
<i>Lonicera morrowii</i>	Morrow's honeysuckle	Areal	---

Latin Name	Common Name	2025 Methods/Actions	2025 Action
<i>Lonicera tatarica</i>	Tatarian honeysuckle	Areal	---
<i>Onopordum acanthium</i>	Scotch thistle	Areal/ Partial Treatment	Manual #1
<i>Rhaponticum repens</i>	Russian knapweed	Areal/Treatment	Manual #1
<i>Saponaria officinalis</i>	bouncingbet	Areal/Treatment	Remove reproductive parts
<i>Silene latifolia</i>	bladder campion	Areal	---
<i>Tamarix ramosissima</i>	salt cedar	Areal/Treatment	Method #3
<i>Tanacetum vulgare</i>	common tansy	Areal/Treatment	Manual #1& 2
<i>Tripleurospermum inodorum</i>	scentless chamomile	Areal/ Partial Treatment	Manual #2
Long Term Monitoring Plot Species Not Monitored since 2019			
<i>Cardaria draba</i>	hoary cress	Plot	---
<i>Carduus nutans</i>	musk thistle	Photo Plot	---
<i>Centaurea diffusa</i> , <i>C. maculosa</i> and hybrid	diffuse, spotted knapweeds	Plot	---
<i>Cirsium arvense</i>	Canada thistle	Plot	---
<i>Euphorbia virgata</i>	leafy spurge	Plot	---

A coordination meeting with the Academy Resource Manager in 2025 occurred to discuss implementation of methods and coordination. It is our hope that both parties communicate with one another for assistance on monitoring and treatment. Monitoring and manual treatments by CNHP in 2025 began in July.

Noxious weed sites east of I-25 were not monitored after discussions with the Academy. The area east of I-25 is being developed and Pine Creek is a highly disturbed system where treating weeds would likely not be successful without a restoration plan.

RESULTS AND RECOMMENDATIONS

U.S. Air Force Academy

Noxious weeds have been increasing throughout the Academy since monitoring began in 2002 (Smith and Greenwell, 2019; Figure 2). The most recent basewide survey was undertaken in 2024 with follow-up mapping completed in 2025. The 2024-2025 basewide survey included thirty-one species that were mapped across the Academy, eighteen of which receive yearly areal monitoring and treatments (two species partially mapped, dame's rocket and Tatarian honeysuckle). There are an estimated 7.7 million noxious weed individuals at the Academy which were mapped in 2024 and 2025 (Table 4, Table 5, Figure 2).

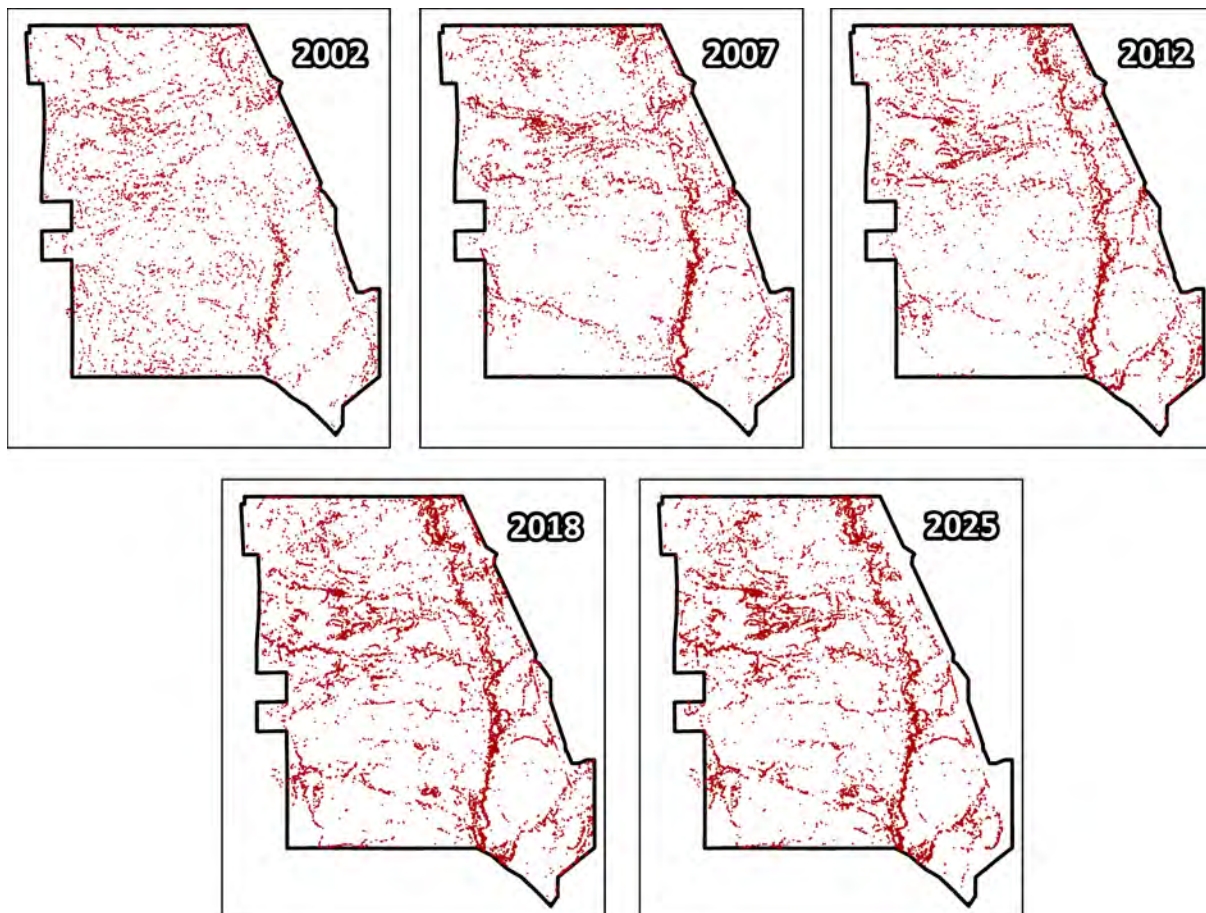


Figure 2. Distribution of known noxious weed occurrences at the U.S. Air Force Academy (excluding yellow toadflax) from 2002 to 2025.

In order to make efficient use of resources, CNHP developed designated mapping areas for Canada thistle at the Academy in 2007 and for all widespread

species at the Academy (Figure 3), meaning only locations within designated mapping areas were surveyed for widespread species in 2012 and the exclusion areas were not surveyed. Designated mapping areas were intended to capture biologically important areas (based on CNHP Potential Conservation Areas) and areas likely to contain weeds. Over time, this concept proved to be problematic for several reasons. Noxious weeds with limited distributions still required comprehensive mapping in exclusion areas and new noxious weed species were discovered in exclusion areas. The result was significant mapping in exclusion areas, defeating the original purpose. From 2023 to 2025 CNHP did not map weeds east of I-25 due to construction activities and the high levels of ongoing disturbance within that small portion of the base (Figure 3).

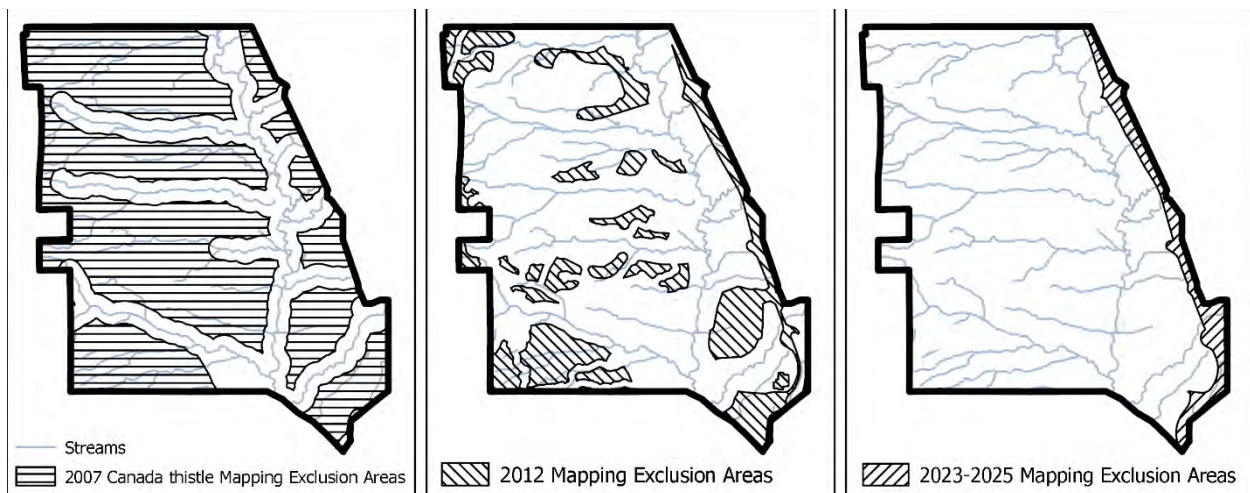


Figure 3. Areas designated for exclusion from mapping at the Academy in 2007 only for Canda thistle (left), exclusion area for all species in 2012 (center), and exclusion for all species from 2023 to 2025 (right).

Additionally, CNHP continually discovers new locations of rare and imperiled species at the Academy and every year more information about the biology and needs of species of concern is known. Potential Conservation Area boundaries are adjusted based on new information and the designated mapping areas were tied to a specific point in time (2012). For these reasons, CNHP abandoned the idea of designated mapping areas and surveyed the entire base in 2018 and 2024 as well as at the Farish in 2017 and 2025.

Table 4. Summary data for mapped weed occurrences at the Academy from 2002 to 2025

		2002 ²				2007				2012				2018				2025			
Scientific Name	Common Name	Occupied Acres	Estimated Shoots	Extant Features	Eradicated Features	Occupied Acres	Estimated Shoots	Extant Features	Eradicated Features	Occupied Acres	Estimated Shoots	Extant Features	Eradicated Features	Occupied Acres	Estimated Shoots	Extant Features	Eradicated Features	Occupied Acres	Estimated Shoots	Extant Features	Eradicated Features
<i>Alliaria petiolata</i>	garlic mustard	-	-	-	-	-	-	-	-	-	-	-	-	0.12	4,011	7	0	2.24	59,415	27	27
<i>Caragana arborescens</i>	Siberian peashrub	-	-	-	-	0	0	0	0	9.71	89,270	43	0	24.97	106,348	183	3	28.51	151,370	204	8
<i>Carduus nutans</i>	musk thistle	15.91	2,207	272	-	27.03	49,588	1,020	4	15.20	125,297	1,082	639	21.75	77,442	1,909	1,118	22.62	77,777	1,464	1,833
<i>Centaurea diffusa</i>	diffuse knapweed	45.42	130,589	251	-	119.86	394,197	913	0	100.6	1,334,253	1,255	406	158.4	1,423,367	2,407	630	178.33	1,791,273	2,679	850
<i>Centaurea stoebe</i>	spotted knapweed	4.67	3,485	54	-	57.52	127,627	319	16	53.02	543,144	565	156	48.92	479,304	846	276	62.43	569,760	1,090	351
<i>Centaurea × psammogena</i>	hybrid knapweed	-	-	-	-	1.75	2,810	118	0	5.93	42,991	240	54	2.42	22,110	279	155	2.25	7,550	260	215
<i>Cirsium arvense</i>	Canada thistle	79.27	408,121	358	-	90.68	379,992	543	0	90.17	1,079,070	776	221	92.35	1,718,919	1,126	401	123.63	2,655,257	1,735	531
<i>Cirsium vulgare</i>	bull thistle	5.54 ¹	596 ¹	73 ¹	-	6.42	4,347	128	0	1.19	4,089	207	79	3.96	14,982	407	170	3.93	16,406	386	319
<i>Cynoglossum officinale</i>	hounds-tongue	-	-	-	-	-	-	-	-	0.01	70	3	9	0.51	4,514	50	22	2.29	10,761	109	53
<i>Dipsacus fullonum</i>	common teasel	18.33	1,693	35	-	10.51	53,454	181	0	9.26	116,595	319	65	11.27	123,921	364	185	11.87	189,750	397	231
<i>Elaeagnus angustifolia</i> [†]	Russian olive	49.79	1,310	269	-	19.08	633	114	156	16.27	689	193	200	6.91	653	108	322	6.22	669	101	335
<i>Euphorbia myrsinites</i>	myrtle spurge	-	-	-	-	0.18	1,021	7	0	0.23	113	10	25	0.51	222	26	35	0.25	247	12	59
<i>Euphorbia virgata</i>	leafy spurge	0.91	28,338	32	-	7.58	336,337	152	2	10.64	275,713	204	30	11.16	227,961	214	78	13.97	266,574	240	84
<i>Galium verum</i>	spring bedstraw	-	-	-	-	0	700	1	0	0	0	0	1	0	102	1	0	0.52	189,607	11	2
<i>Hesperis matronalis</i>	dames rocket	-	-	-	-	0	0	0	0	0.83	16,871	14	0	0.04	665	8	17	0.006	1	1	3

¹ values from field notes.

² 2002 values are sums of 2002 and 2003 mapping.

Table 5. Summary data for mapped weed occurrences continued at the Academy from 2002 to 2025

		2002 ²				2007				2012				2018				2025			
Scientific Name	Common Name	Occupied Acres	Estimated Shoots	Extant Features	Eradicated Features	Occupied Acres	Estimated Shoots	Extant Features	Eradicated Features	Occupied Acres	Estimated Shoots	Extant Features	Eradicated Features	Occupied Acres	Estimated Shoots	Extant Features	Eradicated Features	Occupied Acres	Estimated Shoots	Extant Features	Eradicated Features
<i>Hypericum perforatum</i>	common St. John's wort	<0.1 ¹	363 ¹	5	-	0.86	44,745	10	0	1.16	83,115	29	10	1.26	16,416	57	27	1.69	6,730	64	50
<i>Lepidium draba</i>	hoary cress	20.47	1,671,728	164	-	12.76	1,035,489	241	0	13.08	828,036	203	77	19.52	1,707,408	300	58	28.48	1,558,419	323	83
<i>Lepidium latifolium</i>	perennial pepperweed	-	-	-	-	-	-	-	-	-	-	-	-	0.02	213	2	0	0.16	171	2	1
<i>Leucanthemu m vulgare</i>	oxeye daisy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	12
<i>Linaria dalmatica</i>	Dalmatian toadflax	-	-	-	-	<0.1	10	1	-	0	0	0	3	0.01	52	1	3	0.01	12	1	4
<i>Lonicera morrowii</i>	Morrow's honeysuckle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.37	?	7	0
<i>Lonicera tatarica</i>	Tatarian honeysuckle	NA	NA	NA	-	0.15	20	1		0.15	20	1	0	0.60	132	35	5	2.81	581	80	10
<i>Onopordum acanthium</i>	Scotch thistle	0.17 ¹	52 ¹	7	-	1.31	1,307	36	0	0.30	889	66	73	2.04	1,914	275	143	4.15	6,509	264	306
<i>Rhaponticum repens</i>	Russian knapweed	NA	NA	NA	-	0.03	200	2	2	0.05	543	10	4	0	44	3	11	0.18	114	3	11
<i>Saponaria officinalis</i>	bouncing-bet	0.19	?	1	-	-	-	-	-	-	-	-	-	0.17	4,585	26	8	0.39	2,535	40	20
<i>Silene latifolia</i>	bladder campion	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.19	2,646	34	0
<i>Tamarix ramosissima</i>	salt cedar	<0.01	1	1	-	0	1	1	1	0.00	1	1	4	0.01	2	2	8	0.002	2	2	11
<i>Tanacetum vulgare</i>	common tansy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.012	420	1	2
<i>Tripleurosperm um inodorum</i>	scentless chamomile	-	-	-	-	-	-	-	-	-	-	-	-	0.41	2,530	117	2	2.18	2,886	153	85
Totals		234.96	2,247,472	1,449	-	355.7	2,432,478	3,788	181	327.8	4,540,769	5,221	2,056	407.4	5,937,817	8,753	3,677	499.7	7,567,442	9,690	5,496

¹ values from field notes.
² 2002 values are sums of 2002 and 2003 mapping.

Table 6. Summary data for mapped weed occurrences at the Academy from 2002 to 2025

Scientific Name	Common Name	Overall Trend	2025 Occupied Acres	2002 - 2007 % Change	2007 - 2012 % Change	2012 - 2018 % Change	2018 - 2025 %change	Overall % Change Occupied Acres	2025 Estimated Shoots	2002 - 2007 % Change	2007 - 2012 % Change	2012 - 2018 % Change	2018 - 2025 % Change	Overall % change Estimated Shoots	2025 Extant Features	2002 - 2007 % Change	2007 - 2012 % Change	2012 - 2018 % Change	2018 - 2025 %change	Overall % change Extant Features
<i>Alliaria petiolata</i>	garlic mustard	Rapidly Increasing	2.24	NA	NA	NA	1781%	1781%	59,415	NA	NA	NA	1381%	1381%	27	NA	NA	NA	286%	286%
<i>Caragana arborescens</i>	Siberian peashrub	Increasing	28.51	NA	NA	157%	14%	194%	151,370	NA	NA	19%	42%	70%	204	NA	NA	326%	11%	374%
<i>Carduus nutans</i>	musk thistle	Increasing	22.62	70%	-44%	43%	4%	42%	77,777	2147%	153%	-38%	0%	3424%	1,464	275%	6%	76%	-23%	438%
<i>Centaurea diffusa</i>	diffuse knapweed	Increasing	178.33	164%	-16%	57%	13%	293%	1,791,273	202%	238%	7%	26%	1272%	2,679	264%	37%	92%	11%	967%
<i>Centaurea stoebe</i>	spotted knapweed	Increasing	62.43	1131%	-8%	-8%	28%	1236%	569,760	3562%	326%	-12%	19%	16249%	1,090	491%	77%	50%	29%	1919%
<i>Centaurea × psammogena</i>	hybrid knapweed	Increasing	2.25	NA	239%	-59%	-7%	29%	7,550	NA	1430%	-49%	-66%	169%	260	NA	103%	16%	-7%	120%
<i>Cirsium arvense</i>	Canada thistle	Increasing	123.63	14%	-1%	2%	34%	56%	2,655,257	-7%	184%	59%	54%	551%	1,735	52%	43%	45%	54%	385%
<i>Cirsium vulgare</i>	bull thistle	Stable	3.93	NA	-82%	234%	-1%	-29%	16,406	NA	-6%	266%	10%	2653%	386	NA	62%	97%	-5%	429%
<i>Cynoglossum officinale</i>	hounds-tongue	Rapidly Increasing	2.29	NA	-1000%	5949%	346%	26908%	10,761	NA	-26%	6349%	138%	15273%	109	NA	-63%	1567%	118%	3533%
<i>Dipsacus fullonum</i>	common teasel	Increasing	11.87	-43%	-12%	22%	5%	-35%	189,750	3057%	118%	6%	53%	11108%	397	417%	76%	14%	9%	1034%
<i>Elaeagnus angustifolia</i>	Russian olive	Decreasing	6.22	-66%	-19%	-37%	-10%	-88%	669	-51%	5%	13%	2%	-49%	101	0%	75%	-38%	-6%	-62%
<i>Euphorbia myrsinites</i>	myrtle spurge	Decreasing	0.25	NA	30%	123%	-51%	43%	247	3984%	-89%	96%	11%	-76%	12	0%	43%	160%	-54%	71%
<i>Euphorbia virgata</i>	leafy spurge	Increasing	13.97	737%	40%	5%	25%	1443%	266,574	1087%	-18%	-17%	17%	841%	240	375%	34%	5%	12%	650%
<i>Galium verum</i>	spring bedstraw	Rapidly Increasing	0.52	NA	-100%	NA	67092%	7439%	189,607	NA	-100%	NA	185789%	26987%	11	NA	-100%	NA	1000%	1000%
<i>Hesperis matronalis</i>	dames rocket	Decreasing	0.006	NA	NA	-96%	-82%	-99%	1	NA	NA	-96%	-100%	-100%	1	NA	NA	-43%	-88%	-93%

Table 7. Summary data for mapped weed occurrences at the Academy from 2002 to 2025

Scientific Name	Common Name	Overall Trend	2025 Occupied Acres	2002 - 2007 % Change	2007 - 2012 % Change	2012 - 2018 % Change	2018 - 2025 %change	Overall % Change Occupied Acres	2025 Estimated Shoots	2002 - 2007 % Change	2007 - 2012 % Change	2012 - 2018 % Change	2018 - 2025 %change	Overall % change Estimated Shoots	2025 Extant Features	2002 - 2007 % Change	2007 - 2012 % Change	2012 - 2018 % Change	2018 - 2025 %change	Overall % change Extant Features
<i>Hypericum perforatum</i>	common St. John's wort	Increasing	1.69	NA	34%	9%	34%	1587%	6,730	NA	86%	-80%	-59%	1754%	64	NA	190%	97%	12%	1180%
<i>Lepidium draba</i>	hoary cress	Stable	28.48	-38%	3%	49%	46%	39%	1,558,419	-38%	-20%	106%	-9%	-7%	323	47%	-16%	48%	8%	97%
<i>Lepidium latifolium</i>	perennial pepperweed	Stable	0.156	NA	NA	NA	704%	704%	171	NA	NA	NA	-20%	-20%	2	NA	NA	NA	0%	0%
<i>Leucanthemum vulgare</i>	oxeye daisy	Unknown	0	NA	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	0	NA	NA	NA	NA	NA
<i>Linaria dalmatica</i>	Dalmatian toadflax	Stable	0.01	NA	NA	NA	0%	24%	12	NA	-100%	NA	-77%	20%	1	NA	-100%	NA	0%	0%
<i>Lonicera morrowii</i>	Morrow's honeysuckle	Unknown	?	NA	NA	NA	NA	NA	?	NA	NA	NA	NA	NA	7	NA	NA	NA	NA	NA
<i>Lonicera tatarica</i>	Tatarian honeysuckle	Increasing	2.81	NA	0%	298%	368%	1764%	581	NA	0%	560%	340%	2805%	80	NA	0%	3400%	129%	7900%
<i>Onopordum acanthium</i>	Scotch thistle	Rapidly Increasing	4.15	212%	-77%	578%	104%	2343%	6,509	854%	-32%	115%	240%	12417%	264	200%	83%	317%	-4%	3671%
<i>Rhaponticum repens</i>	Russian knapweed	Stable	0.18	NA	69%	-61%	770%	478%	114	NA	172%	-92%	159%	-43%	3	NA	400%	-70%	0%	50%
<i>Saponaria officinalis</i>	bouncingbet	Stable	0.39	NA	NA	-67%	136%	136%	2,535	NA	NA	-89%	-45%	-45%	40	?	?	225%	54%	54%
<i>Silene latifolia</i>	bladder campion	Unknown	0.19	NA	NA	NA	NA	NA	2,646	NA	NA	NA	NA	NA	34	NA	NA	NA	NA	NA
<i>Tamarix ramosissima</i>	salt cedar	Stable	0.002	0%	0%	704%	-75%	-84%	2	0%	0%	100%	0%	100%	2	0%	0%	100%	0%	100%
<i>Tanacetum vulgare</i>	common tansy	Unknown	0.012	NA	NA	NA	NA	NA	420	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA
<i>Tripleurospermum inodorum</i>	scentless chamomile	Likely Increasing	2.18	NA	NA	52741%	428%	428%	2,886	NA	NA	126400%	14%	14%	153	NA	NA	11600%	31%	31%

Precipitation

Annual precipitation, especially in the spring and summer months, can be a helpful indicator for interpreting weed monitoring data. Higher precipitation years often result in increased weed numbers for that year. The average annual precipitation calculated for the years 2006 to 2025 is 15.25 inches (National Centers for Environmental Information, n.d.). The annual precipitation in 2025 was 16.30 inches, 1.05 inches above the 20-year average. 12.58 inches fell during the spring and summer months (March to August). A summary of the average spring and summer precipitation (March to August) shows that 2004, 2015, 2017, and 2023 were above average for spring and summer precipitation, while 2002, 2008, and 2012 were particularly dry years (Figure 4). Musk thistle, Scotch thistle, and houndstongue have population increases that are correlated with higher precipitation patterns (Zouhar, 2002a; Zouhar, 2002b). Additionally, some species such as myrtle spurge will have large sprouting events during wet years, but seed will remain dormant during dry years.

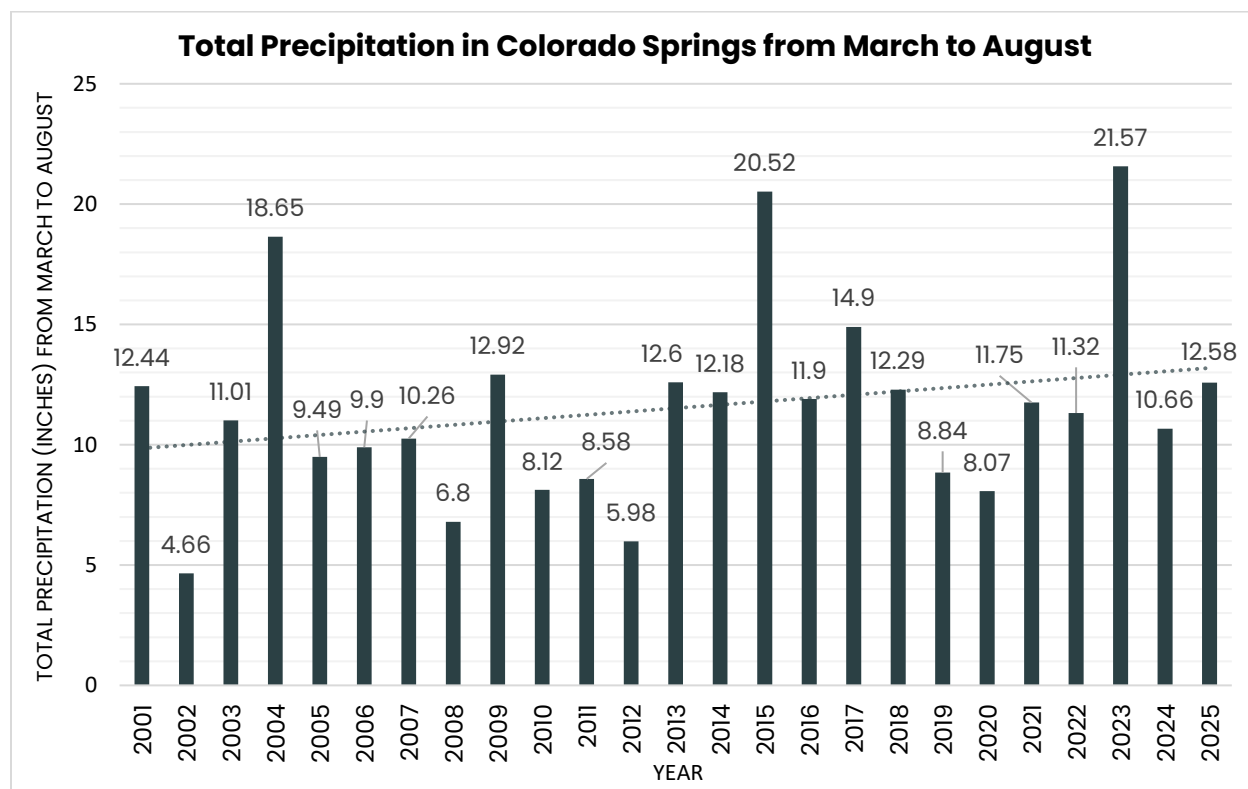


Figure 4. The total spring and summer (March-August) precipitation at the Colorado Springs Municipal Airport (USW00093037) (National Centers for Environmental Information, n.d.). Blue dotted line is the trend line.

Farish Recreation Area

In 2025, the entire Farish Recreation Area was surveyed for noxious weeds. Four noxious weed species were mapped within the Farish. In all, 571 extant occurrences covering approximately 44.68 acres were documented (Table 8). Noxious weeds have been increasing throughout Farish since monitoring began in 2002 (Figure 5, Figure 6). Areal mapping species included, musk thistle (*Carduus nutans*), Canada thistle (*Cirsium arvense*), orange hawkweed (*Hieracium aurantiacum*), and yellow toadflax (*Linaria vulgaris*).

Canada thistle and musk thistle were comprehensively mapped, and both have increased since 2017. Yellow toadflax remains the most widespread noxious weed at Farish. Large (> approximated ¼ acre) occurrences of yellow toadflax were mapped, but smaller infestations were not mapped due to its widespread distribution. Summary data for mapped weed infestations at Farish 2002–2025 are included in Table 8 and changes in weed distribution and abundance are provided in Table 9.

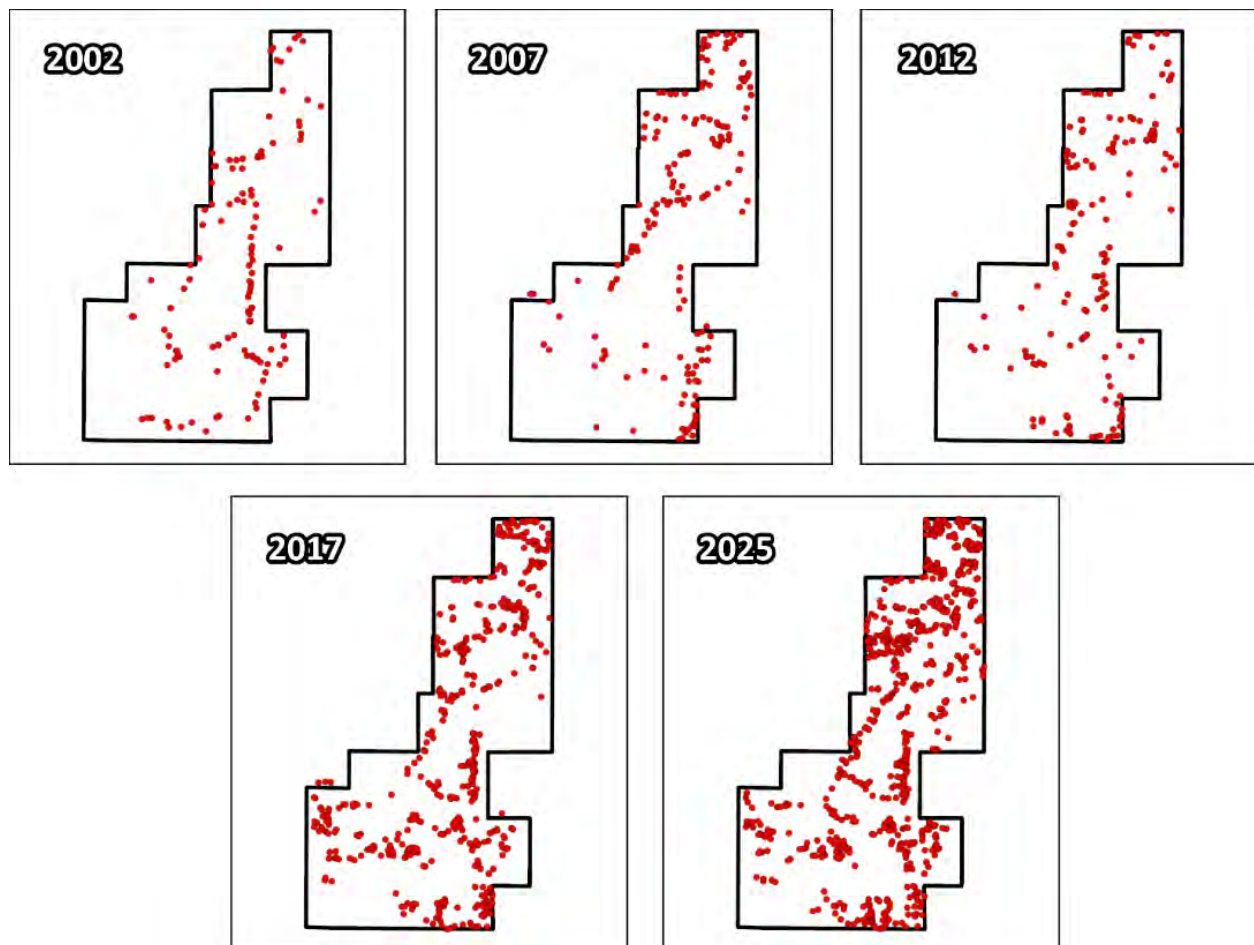


Figure 5. Distribution of known noxious weed occurrences at Farish

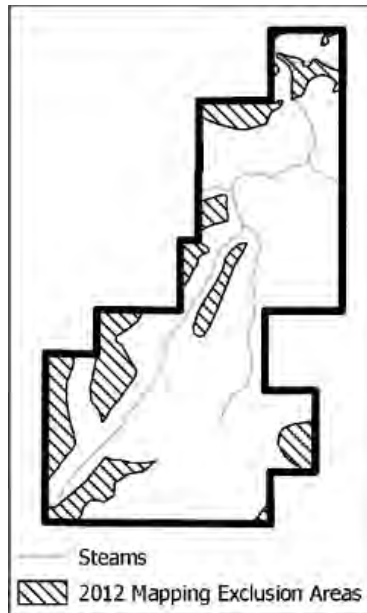


Figure 6. Areas designated for exclusion from mapping at the Farish in 2012.

Table 8. Summary data for mapped weed occurrences at Farish from 2002 to 2025 during survey years.

Species		2002				2007				2012				2017				2025			
Scientific Name	Common Name	Occupied Acres	Estimated Shoots	Extant Features	Eradicated Features	Occupied Acres	Estimated Shoots	Extant Features	Eradicated Features	Occupied Acres	Estimated Shoots	Extant Features	Eradicated Features	Occupied Acres	Estimated # of Shoots	Extant Features	Eradicated Features	Occupied Acres	Estimated Shoots	Extant Features	Eradicated Features
<i>Carduus nutans</i>	musk thistle	0.85	57	14	-	2.77	1,269	44	1	1.43	3,456	87	21	12.48	568,697	357	21	14.72	455,991	446	173
<i>Cirsium arvense</i>	Canada thistle	0.23	3,488	8	-	1.55	14,734	23	1	1.27	24,082	35	8	3.96	169,599	74	10	4.80	131,867	124	39
<i>Euphorbia virgata</i>	leafy spurge	-	-	-	-	0.03	113	1	0	0.03	113	1	0	0.31	94,248	1	0	0.00	0	0	0
<i>Hieracium aurantiacum</i>	orange hawkweed	-	-	-	-	-	-	-	-	-	-	-	-	0.007	200	1	0	0.003	39	1	0
<i>Linaria vulgaris</i>	common toadflax	-	-	-	-	0.18	9,470	6	0	6.01	18,179	32	0	9.15	57,515	44	1	25.16	720,375	147	7
Totals		1.08	3,545	22	-	5	25,586	74	2	9	45,830	155	29	26	890,259	477	32	45	1,308,272	718	219

Table 9. Changes in weed distribution and abundance at Farish from 2002 to 2025 during survey years.

Scientific Name	Common Name	Overall Trend	2025 Occupied Acres	2002 - 2007 % Change	2007 - 2012 % Change	2012 - 2017 % Change	2017-2025 % Change	Overall % Change Occupied Acres	2025 Estimated # of Shoots	2002 - 2007 % Change	2007 - 2012 % Change	2012 - 2017 % Change	2017-2025 % Change	Overall % change Estimated # of Shoots	2025 # of Extant Features	2002 - 2007 % Change	2007 - 2012 % Change	2012 - 2017 % Change	2017-2025 % Change	Overall % change # of Extant Features
<i>Carduus nutans</i>	musk thistle	Rapidly Increasing	14.72	1.99	-0.54	8.87	18%	1691%	455,991	10.48	3.40	196.55	-20%	814170%	446	2.23	1.00	2.99	25%	3331%
<i>Cirsium arvense</i>	Canada thistle	Rapidly Increasing	4.80	5.77	-0.18	211%	21%	2002%	131,867	3.22	0.63	604%	-22%	3681%	124	1.88	0.52	106%	68%	1450%
<i>Euphorbia virgata</i>	leafy spurge	Decreasing	0.00	NA	0%	1017%	-100%	-100%	0	NA	0%	83305%	-100%	-100%	0	NA	0%	0%	-100%	-100%
<i>Hieracium aurantiacum</i>	orange hawkweed	Decreasing	0.003	NA	NA	NA	-56%	-56%	39	NA	NA	NA	-81%	-81%	1	NA	NA	NA	0%	0%
<i>Linaria vulgaris</i>	common toadflax	Rapidly Increasing	25.16	NA	3239%	52%	175%	13878%	720,375	NA	92%	216%	1152%	7507%	147	NA	433%	38%	234%	2350%

Garlic Mustard (*Alliaria petiolata*)

Change from 2024–2025: Rapidly Increasing
Management Goals: Eradication/Containment
State List: Watch List



- Obligate biennial (Paulus and Marshall, 2022)
- Self-fertile (Cavers et al., 1979; Paulus and Marshall, 2022)
- Germination in early spring, often triggered by the first warm rains of the season (Munger, 2001).
- Reproduction by seed only (Cavers et al., 1979; Munger, 2001).
- A small percentage of seeds can be viable for 4–6 years (Munger, 2001).
- Crushed leaves smell like garlic (Munger, 2001)
- Can form a monoculture where the soil is kept moist, for instance in riparian zones and under deciduous trees (Cavers et al., 1979; Munger, 2001).



Figure 7. *Alliaria petiolata* found at the Air Force Academy in May 2024, primarily basal growth, note the rounded basal leaves (left), flowering and fruiting (right) – Photos by Robert Monahan

2025 Mapping Results

Six new garlic mustard sites were discovered southeast of the Berry Goldwater Visitor Center. The seven sites near the visitor center contain an estimated 9,500 individuals (Table 10, Figure 7, Figure 8, Grid D-2, Map 3). Garlic mustard is the dominant species growing in the shade of oaks and chokecherries. Black bindweed (*Fallopia convolvulus*), an introduced species, is associated with garlic mustard and can be found growing up the garlic mustard stems at these sites. There are twenty extant sites along West Monument Creek which contain an estimated 49,500 individuals (Figure 9, Grid H-5, H-6, and I-6, Map 3). Garlic mustard has continually increased at the Academy since it was first mapped in 2018 (Table 6, Map 2).



Figure 8. Garlic mustard near the Berry Goldwater Visitors Center (orange circle) in 2025. The red areas indicate site where garlic mustard is extant and red indicate eradicated sites.



Table 10. Mapping of garlic mustard at the Academy during the first pass.

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002	---	---	---	---
2007	---	---	---	---
2012	---	---	---	---
2018	0.12	4,011	7	0
2019	0.21	6,564	8	0
2020	1.03	24,660+	12	2
2021	1.73	50,890	41	1
2022	---	---	---	---
2023	1.71	13,303	21	26
2024	2.10	53,389	21	27
2025 ¹	2.24	59,415	27	27

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

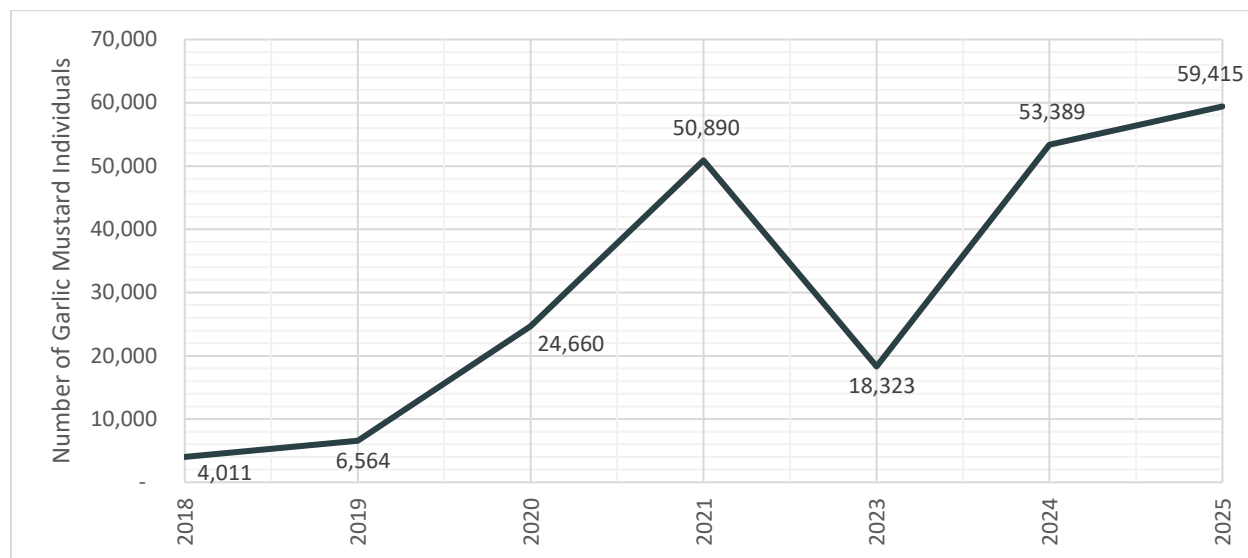


Figure 10. Number of garlic mustard individuals mapped during the first pass from 2018 to 2025.

2025 Treatment

In 2025 manual treatments were deprioritized for garlic mustard because at most sites the plants had already gone to seed at the time of the survey. There was a greater risk of spreading seeds and low likelihood that manual treatments would be an effective way to reduce a population's viability.

From 2020 to 2025 a combination of pulling and herbicide applications was used to control the garlic mustard. Manual treatments are more time consuming but

have far less off-target damage to native vegetation which is the best defense against invasion. Herbicides covering large areas can be destructive to native vegetation thereby creating condition favorable to garlic mustard especially around riparian areas along west monument creek where water can transport herbicides downstream from the initial treatment area. While these methods did appear to control garlic mustard initially, sprouts are continuing to be mapped along the banks of West Monument Creek and southeast of the visitor center. Not all garlic mustard sites were treated or were partially treated due to the enormous number of sites and plants. Manual treatments were focused on sites with a smaller overall number of individuals where treatments have the potential to be effective.

Table 11. Monitoring and treatment of garlic mustard sites at the Academy in 2025.

Pass & Year	# Sites Visited	Estimated # Shoots Mapped	# Manually Treated Shoots	# Sites with Plants	# Sites without Plants
2025 Pass 1	11	9,454	754	7	4
2025 Pass 2	1	0	0	0	1
2025 Total	12	9,454	754	---	---
2019	11	6,564	5,997	---	----
2020	22	24,791	2,422	---	---
2021	44	51,400	1,112	---	---
2022	---	---	---	---	---
2023	48	15,243	2,142	---	---
2024	49	53,389	2,263	---	---
2025	12	9,454	754	---	---

Potential sources of garlic mustard seeds are the horse barns upstream and the residential sites upslope of West Monument Creek. Many garlic mustard infestations are correlated with disturbances especially anthropogenic disturbances (Munger, 2001). There are three factors that point to this at the Academy: 1) all occurrences along West Monument Creek are downstream and down slope from the horse barns and large manicured landscapes, 2) yard waste was observed in dump areas on the slopes of West Monument Creek and 3) common garden escapes were observed downslope of these residences including the wayfaring tree (*Viburnum lantana*), white campion (*Silene latifolia*), common tansy (*Tanacetum vulgare*) a List B noxious weed found in 2020, as well as a state watch listed noxious weed, hoary alyssum (*Berteroa incana*). Contacting residents might be worthwhile to prevent continued introduction of noxious weeds into West Monument Creek.

Garlic mustard is a Colorado watch list species, but it has shown itself to be highly invasive at the Air Force Academy and is considered noxious in many states in the eastern U.S. (Munger, 2001). Watch List is defined by the Colorado Department of Agriculture (2025) as “intended to serve advisory and educational purposes only”. Its purpose is to encourage the identification and reporting of these species to the Commissioner in order to facilitate the collection of information to assist the Commissioner in determining which species should be designated as noxious weeds.” (Colorado Department of Agriculture, 2025).

Recommendations

Garlic mustard is a highly invasive species that has become established in West Monument Creek along the eastern part of the Academy. This species is extremely difficult to impossible to control once established due to the plant’s prolific seed production. The stream banks are frequently scoured and provide a constant source of open habitats that promote seed establishment. The cover is high and local treatments may reduce the populations. However, the removal of the plants whether by chemical or manual methods, leaves behind the open soils that are ripe for more invasion. Manual treatments of garlic mustard have potential to reduce populations of garlic mustard or at least not increase number of seedlings in the following year. However, herbicide treatments and treatments involving herbicide and manual pulling increase the number of seedlings in the following year (Shartell et al. 2012). Without a way to control inputs or a means to conduct continuous plant removal throughout the growing season, control of this plant is unlikely.

Recommendations for garlic mustard:

- For the population of garlic mustard near the visitor center, consider herbicide treatments for suppression. There is an ephemeral creek in the area, but well-timed herbicide treatments may be effective (Munger, 2001) and could potentially do very little off target damage.
- Consider the potentially constant source of seed influx from the surrounding properties and the difficulty of treating garlic mustard at this stage of infestation. Treatment of garlic mustard is likely a waste of resources if the seeds are being contributed by land use upstream and upslope along West Monument Creek.
- Talk to upslope landowners or residents and survey the properties, if possible, for potential noxious weed inputs. Many of the species sold on the internet and through garden stores are invasive, especially in riparian areas. The hay (even

“weed-free” hay) used for the horses may be a noxious weed seed contributor to West Monument Creek.

- If weed treatments are undertaken for garlic mustard, monitoring the sites needs to be included as part of the plan. After reviewing studies from the eastern U.S. where garlic mustard has been around much longer, it is clear there is no sure way to remove garlic mustard once it has become established. However, manual treatments are more effective in the long-term, but they must be conducted repeatedly over many years (if you can reduce the incoming seed source).

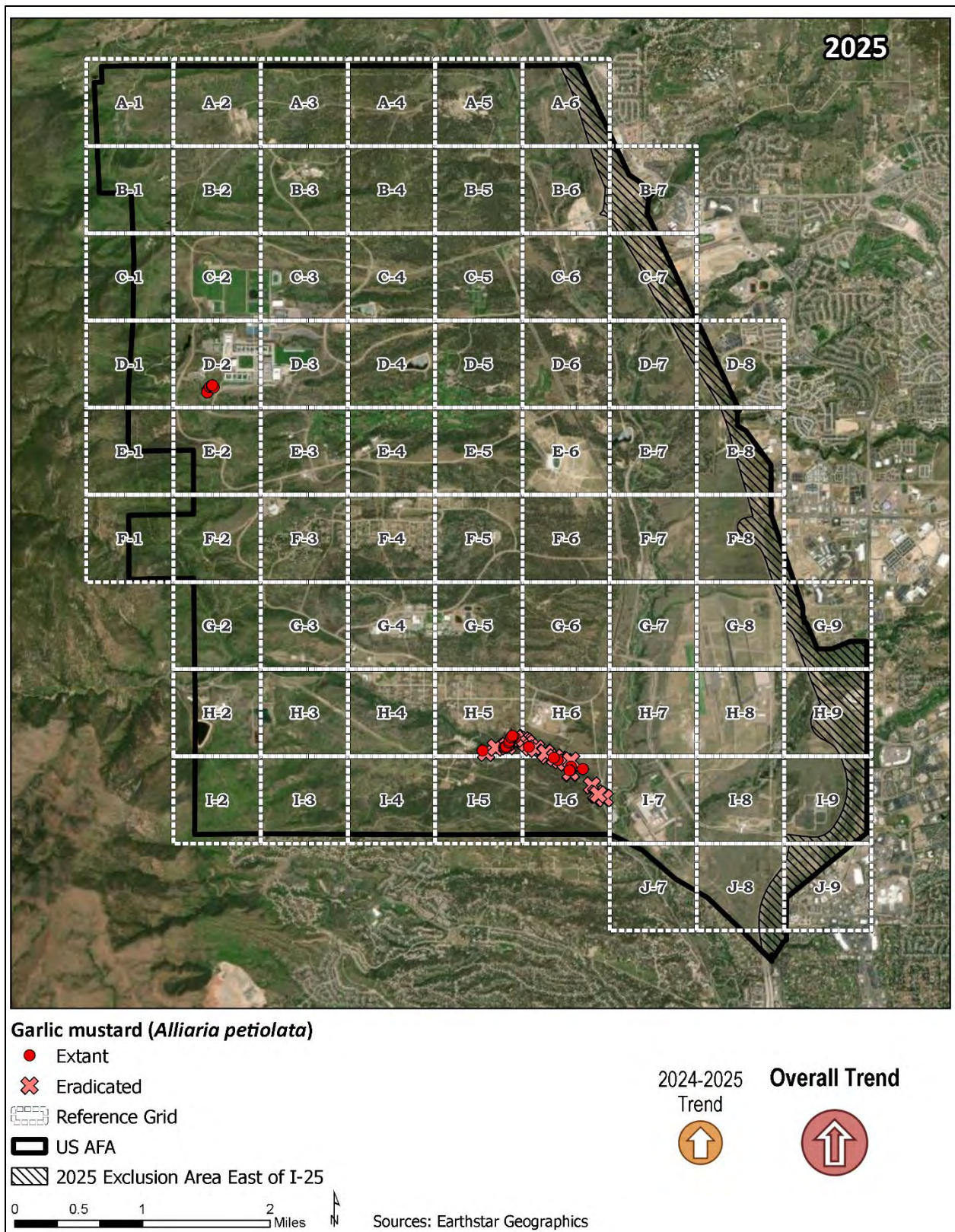
History of Sampling and Treatment:

- Garlic mustard was first discovered during the 2018 base wide survey at seven mapped sites. Herbicide applications were applied to at least two populations along West Monument Creek.
- In 2019, an eighth site was mapped, and the populations have continued to expand. Hand-pulling was done at five sites with one site set up as a monitoring plot to track results. The monitoring plot showed there is likely an extensive seed bank as thousands of sprouts appeared after each manual treatment. The garlic mustard seeds may be coming from residential lawn clippings along West Monument Creek.
- In 2020, a large increase in the number of sprouts was observed along with an increase in the number of mapped sites. A plan to survey earlier and include the entire western part of West Monument Creek, and monitor and treat more frequently is planned for 2021.
- In 2021, West Monument Creek was surveyed from the west side to the east side of the Academy to map the full extent of garlic mustard; the footprint along Monument Creek was extended by fifty-five meters to the west and 28 new sites were mapped with over 50,000 individuals representing a significant increase since 2020.
- In 2022 no surveys or treatments were undertaken.
- In 2023, West Monument Creek was surveyed. A new site was found near the Berry Goldwater Visitor Center which may indicate a new source of garlic mustard seeds unrelated to the stables.

- In 2024, during basewide mapping at the Academy one new site was found along West Monument Creek and the total number of individuals was over 53,000. Manual treatments targeted sites with a small number of individuals where there is a potential for effective suppression and sites with thousands of individuals were not treated.
- In 2025, six new sites were mapped southeast of the Berry Goldwater Visitors Center where garlic mustard was the dominant understory species. Only a small portion of sites along West Monument Creek were visited this year.



Map 2. Garlic mustard at the Academy between 2018 and 2025.



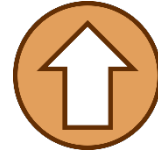
Map 3. Distribution of garlic mustard at the Academy in 2025 with the reference grid.

Siberian Peashrub (*Caragana arborescens*)

Change from 2018–2025: Increasing

Management Goals: Considering Management

State List: Not Listed in Colorado (Escaped Ornamental)



- Shrub or small tree (Minnesota Department of Natural Resources [MDNR], n.d.)
- Ornamental escaping to disturbed wildlands, which is listed as noxious in places in North America (Hinojosa et al., 2025; MDNR, n.d.).
- Nitrogen-fixer (Hinojosa et al., 2025; MDNR, n.d.)
- Blooms in May–June and pods form in June–July (MDNR, n.d.)
- Prefers full sun, sandy open sites.
- Reproduction by seed and vegetative
- Seed longevity at least 5 years in a laboratory
- Allelopathic (Hinojosa et al., 2025).



Figure 11. *Caragana arborescens* with open seed pods in fall at the Academy (left) – Photo by Robert Monahan 2024; *Caragana arborescens* flowering (right) – Photo by Andrew Butko, CC BY-SA 3.0, via Wikimedia Commons

2024–2025 Mapping Results

Siberian peashrub was present on the base in 2002 and 2007; however, Natural Resource Managers noticed it was spreading and it was mapped in 2012 during the basewide weed survey. In 2024 and 2025, 204 features were mapped, a minor increase since 2018. The total number of individuals has increased by 42.3% since 2018 (Table 12, Map 4, and Map 5).

Table 12. Mapping of Siberian peashrub at the Academy.

Year	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2002	---	---	---	---
2007	---	---	---	---
2012 ¹	9.71	89,270	43	---
2018	24.97	106,348	183	3
2024 ²	28.33	147,594	186	8
2025 ³	28.51	151,370	204	8

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Noxious weeds were not mapped basewide and were instead only mapped within designated mapping areas in 2012 (see Figure 3. for designated mapped areas)

² Noxious weeds were not mapped east of I-25 in 2024 due to ongoing construction. 12 Siberian peashrub features which are east of I-25 were excluded from the 2024 mapping and analysis.

³ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

Recommendations

Management urgency for Siberian peashrub is moderate due to the low potential for eradication without a significant investment of resources.

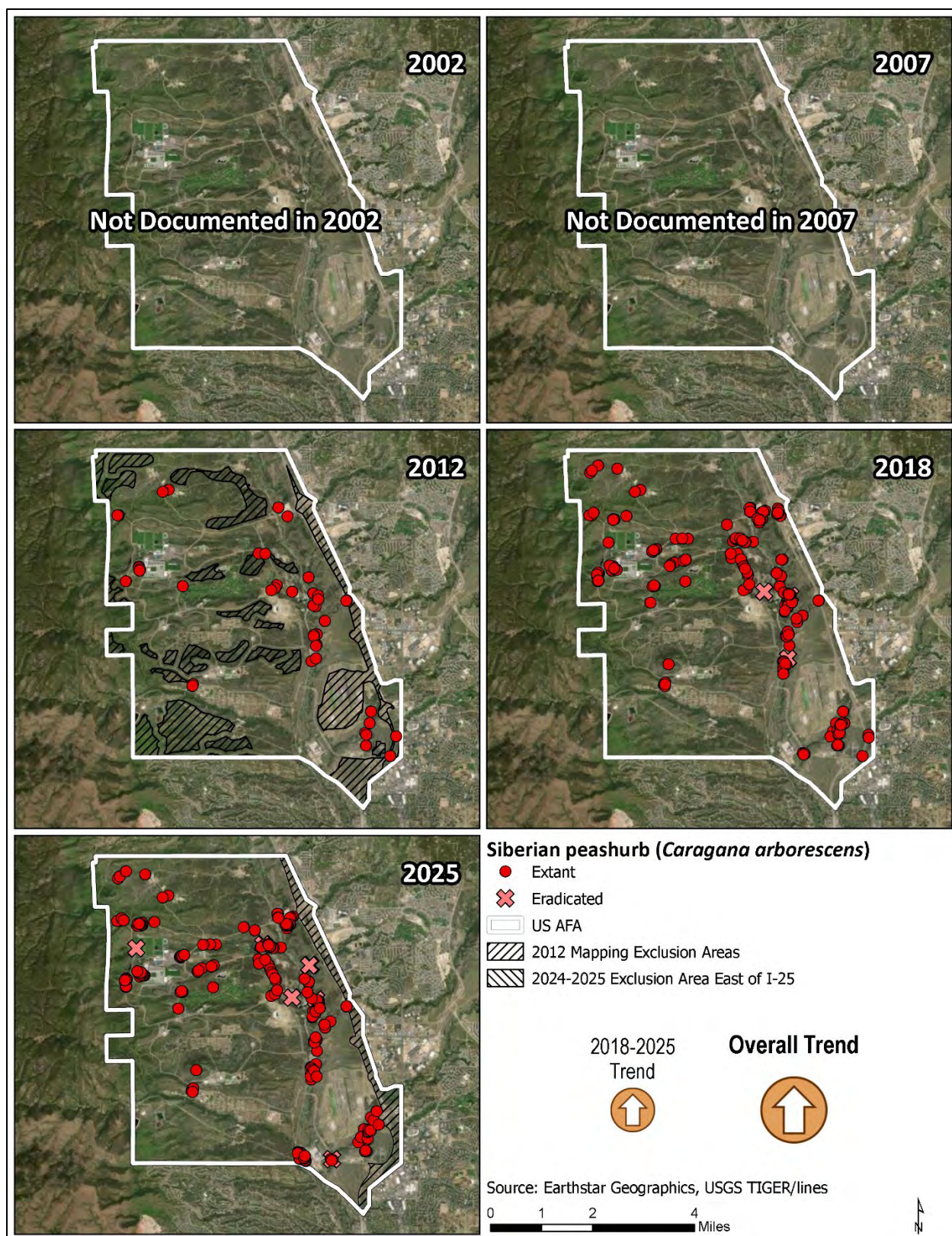
Recommendations for Siberian peashrub:

- Continue to map new locations every five years to monitor if there is a large increase in the number of individuals.

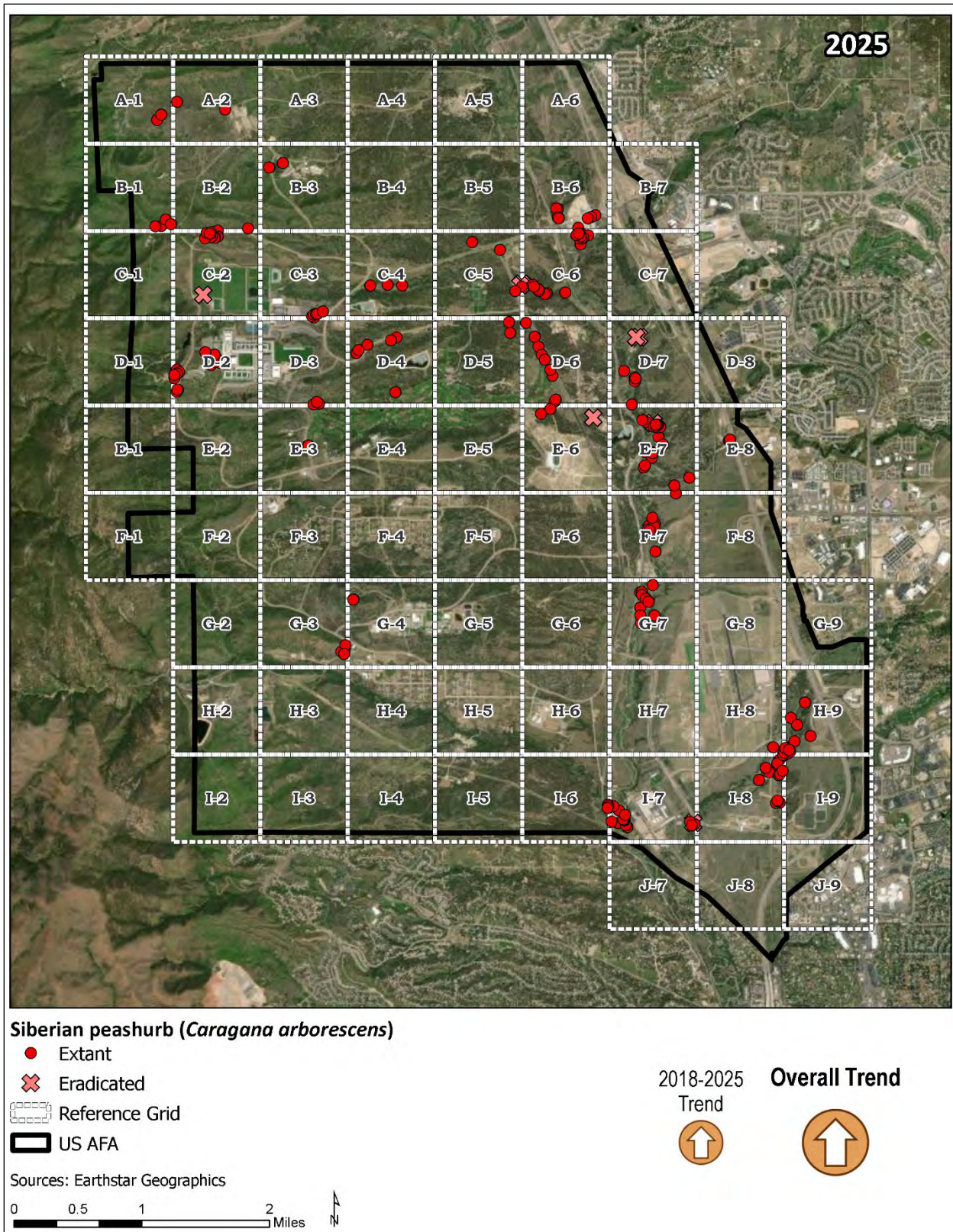
Prescribed burns can be an effective treatment for reducing plant vigor and killing seedlings (Minnesota Department of Natural Resources, n.d.). Cut-stump herbicide treatment is recommended for full grown Siberian peashrub plants (MDNR, (Minnesota Department of Natural Resources, n.d.).

History of Sampling and Treatment

- First mapped in 2012 during the basewide weed survey.
- Results of the 2018 basewide weed survey show the number of mapped features more than tripled and acreage more than doubled between 2012 and 2018.
- In 2024, during the basewide mapping there were several new features mapped at the base and there has been a slight increase in the total occupied area.
- In 2025, supplementary basewide mapping was performed to capture select areas that were not mapped in the 2024 basewide survey. An additional eighteen new features were mapped, and the total number of individuals has increased by 42.3% since 2018.



Map 4. Distribution of Siberian peashrub at the Academy from basewide weed surveys (2002, 2007, 2012, 2018, and 2024-2025).



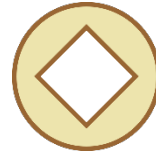
Map 5. Distribution of Siberian peashrub at the Academy from basewide weed survey in 2024-2025.

Musk Thistle (*Carduus nutans*)

Change from 2018–2025: Stable

Management Goals: Suppression

State List: B



- Biennial or winter annual with a taproot (Zouhar, 2002a; Remaley et al., 2005).
- Reproduction only by seed (Zouhar, 2002a).
- Rosettes form early spring, bolts in March to May
- Plants die after they go to seed (Zouhar, 2002a).
- Plants are negatively impacted by drought and most successful in moist soils or with abundant spring rainfall (Zouhar, 2002a).
- Seed longevity of 10–15 years or longer (Zouhar, 2002a; Remaley et al., 2005).



Figure 12. *Carduus nutans* at the Academy as an adult plant in fall (left) and a flowering head (right) – Photos by Robert Monahan, 2024

Air Force Academy 2018–2025 Mapping Results

Overall, the weed mapping data shows musk thistle at the Academy is stable. The occupied acres of musk thistle at the Academy show a correlation to spring–summer precipitation; occupied acres are lower for 2002 and 2013 (low precipitation years) and higher in 2007, 2018, 2024, and 2025 (high precipitation years; Figure 13).

The estimated number of shoots have increased from 2002 to 2012 and then decrease from 2012 to 2024 and 2025 (Table 13, Map 6, and Map 7). The number of occupied acres has been fluctuating with 2002 and 2012 with the lowest occupied acres and 2007, 2018, 2024, 2025 with the highest occupied. There had previously been a correlation between occupied acres and the spring and summer precipitation, but since 2024 the occupied acres have stabilized and therefore is no longer correlated with precipitation (Figure 13).

Table 13. All Mapping of musk thistle at the Academy.

Year	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2002	16.15	2,244	280	---
2007	28.95	76,213	1,072	4
2012¹	17.43	166,992	1,136	639
2018	23.04	105,218	1,977	1,152
2024²	22.72	77,551	1,477	1,813
2025³	22.62	77,777	1,464	1,833

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Noxious weeds were not mapped basewide and were instead only mapped within designated mapping areas in 2012 (see Figure 3 for designated mapped areas).

² Noxious weeds were not mapped east of I-25 in 2024 due to ongoing construction. 77 musk thistle features which are east of I-25 were excluded from the 2024 mapping and analysis.

³ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

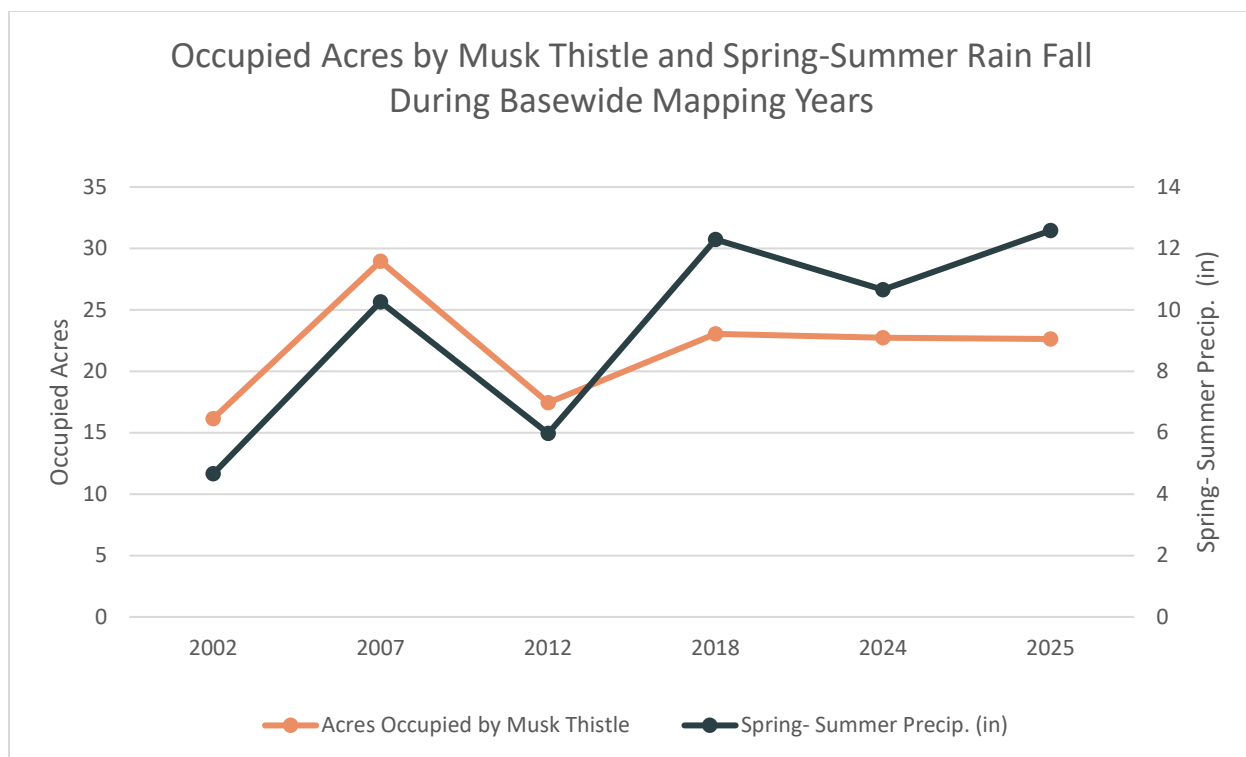


Figure 13. Comparison of spring-summer precipitation and occupied acres of musk thistle at the Academy.

Farish Recreation Area 2025 Mapping Results

The Farish-wide mapping data show an increase in occupied acres and number of extant features but a decrease in the total estimated shoots (Table 14, Map 9). Musk thistle is the second most common noxious weeds species at the Farish after common toadflax. The data indicates that musk thistle is continuing to spread although the total number of individual has not increased since 2017 (Table 9, Table 14, Map 8).

Table 14. All Mapping of musk thistle at the Farish.

Year	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2002	0.85	57	14	---
2007	2.77	1,269	44	1
2012	1.43	3,456	87	21
2017	12.48	568,697	357	21
2025	14.72	455,991	446	173

Farish wide weed mapping was performed in 2002, 2007, 2012, 2017, and 2025, which are the shaded rows.

Recommendations

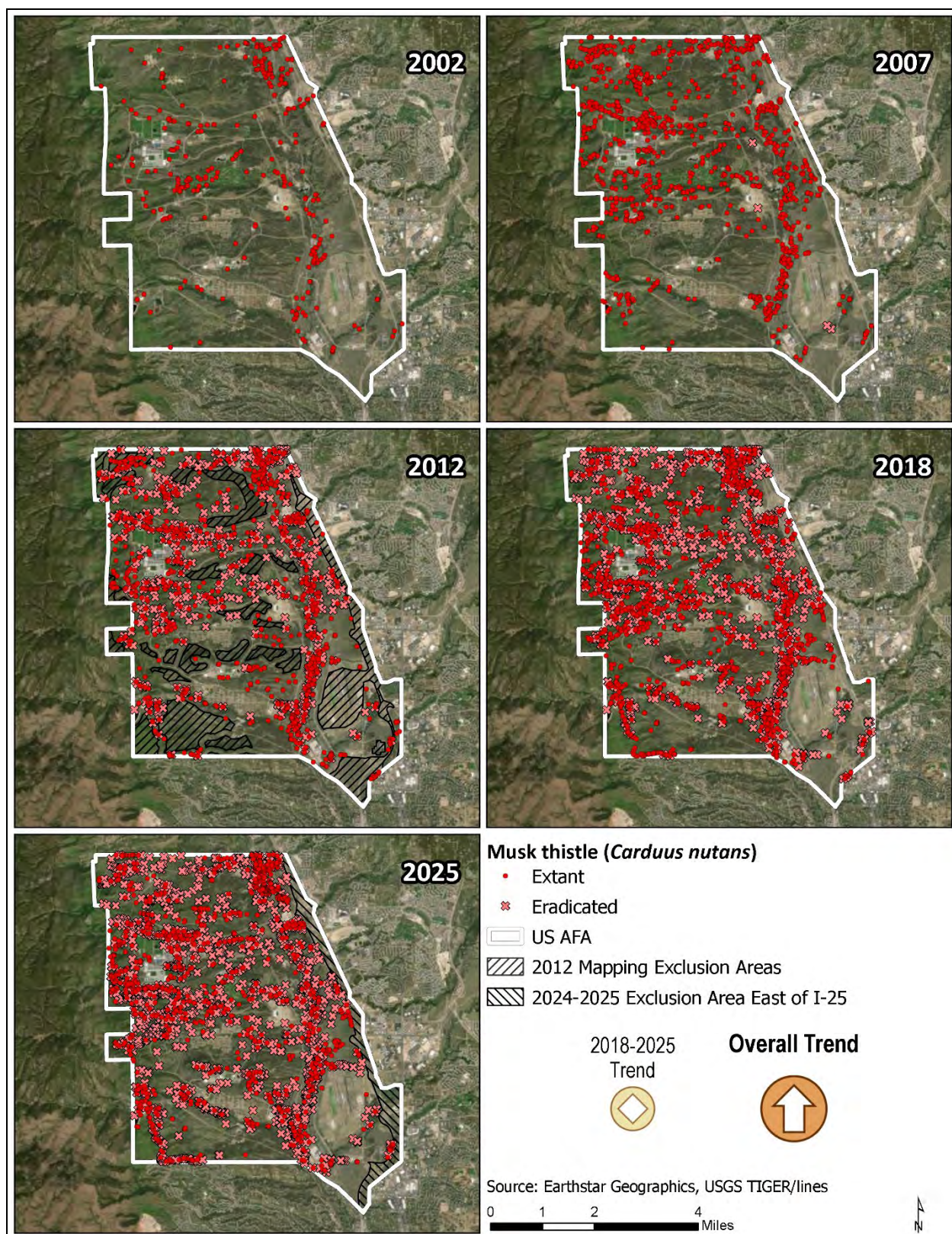
Future treatments should not include broadcast herbicide applications in areas with native vegetation. Spot treatments at the rosette stage or severing the rosettes below the root crown while leaving the root in the ground is recommended to protect the soil from excess disturbance (Remaley et al., 2005). Since this plant is a biennial, it dies after it flowers. The seed heads and/or flowers are still viable on plants treated with herbicide. The soil disturbance from the herbicide overspray creates soil conditions conducive to musk thistle and other weeds such as cheatgrass and smooth brome. In addition, the first-year rosettes which should be the targets for herbicide application or mechanical treatments are missed. The time of year the plants are sprayed, the growth stage of the plants (bolted), the amount of herbicide and overspray, as well as the incomplete treatments need to be addressed to improve treatment success.

Before herbicides are used, a site plan should be prepared because many areas where the plots have been treated are seeing a reduction in the biodiversity of plants and increasing weeds. A non-native and aggressive perennial grass, smooth brome (*Bromus inermis*), which is harder to treat (although it is not on the State Noxious Weed List in Colorado) is becoming dominant. This grass is less beneficial to wildlife and is no longer recommended for use in restorations and plantings because of its "aggressive nature" (Bush, 2006). The result of the herbicide treatment is a decrease in biodiversity even when the weed goals are being met. Once smooth brome dominates it remains in this condition for many years. Repeated herbicide applications over multiple consecutive years are not recommended for this reason.

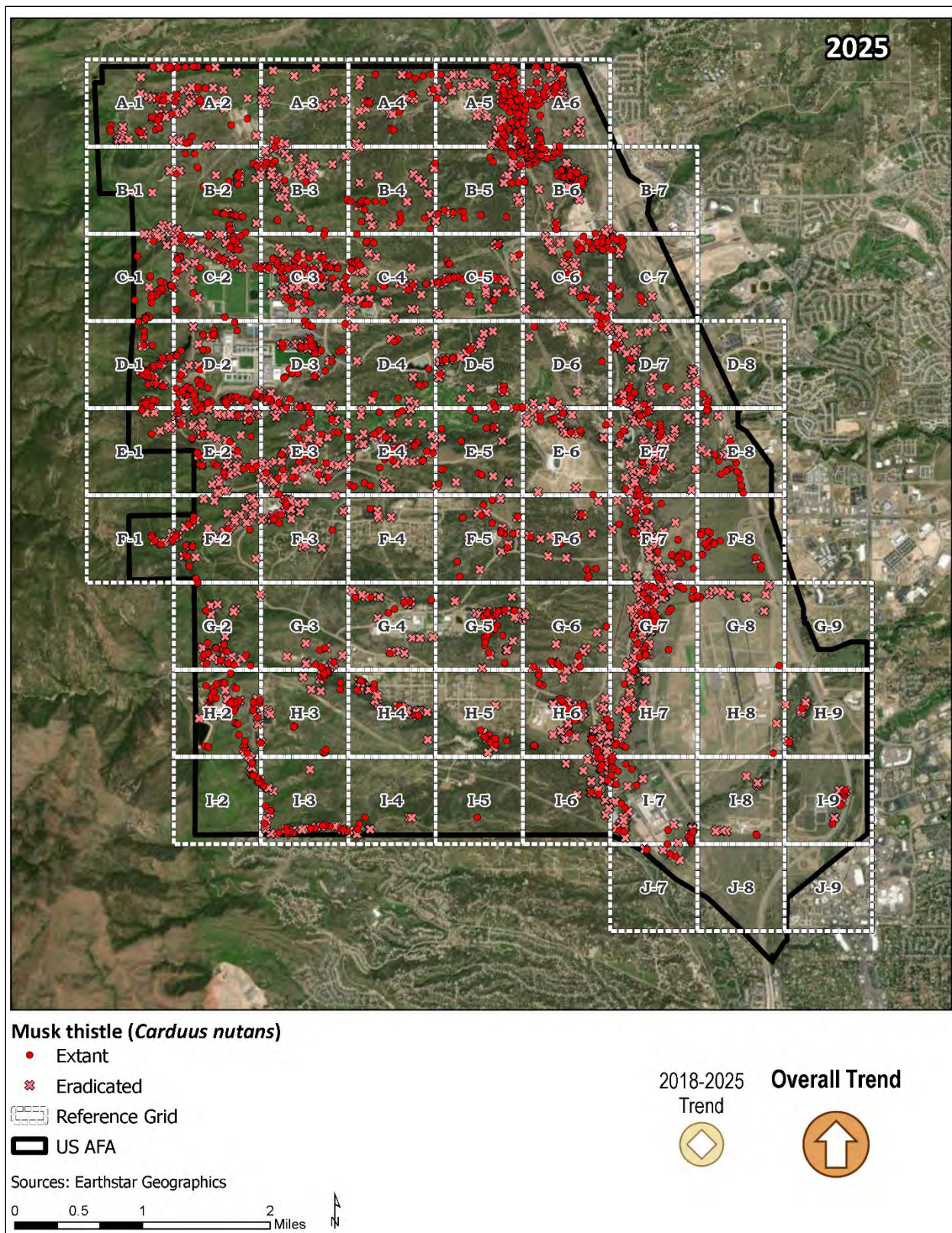
History of Sampling and Treatment

- All ten plots were visited in 2008–2015 with the exception of 2012.
- All plots have been treated at least once if not multiple times with herbicides based on our field observations.
- Census mapping for musk thistle distribution across the Academy property was conducted in 2002, 2007, and 2012.
- The numbers of individuals recorded in the plots in 2015 were significantly lower than when the plots were initiated in 2008. Precipitation patterns may explain the increase in plants noted in 2015. Two years in a row at CANU 2 a native plant (*Scrophularia lanceolata*) appeared to be treated with herbicides.

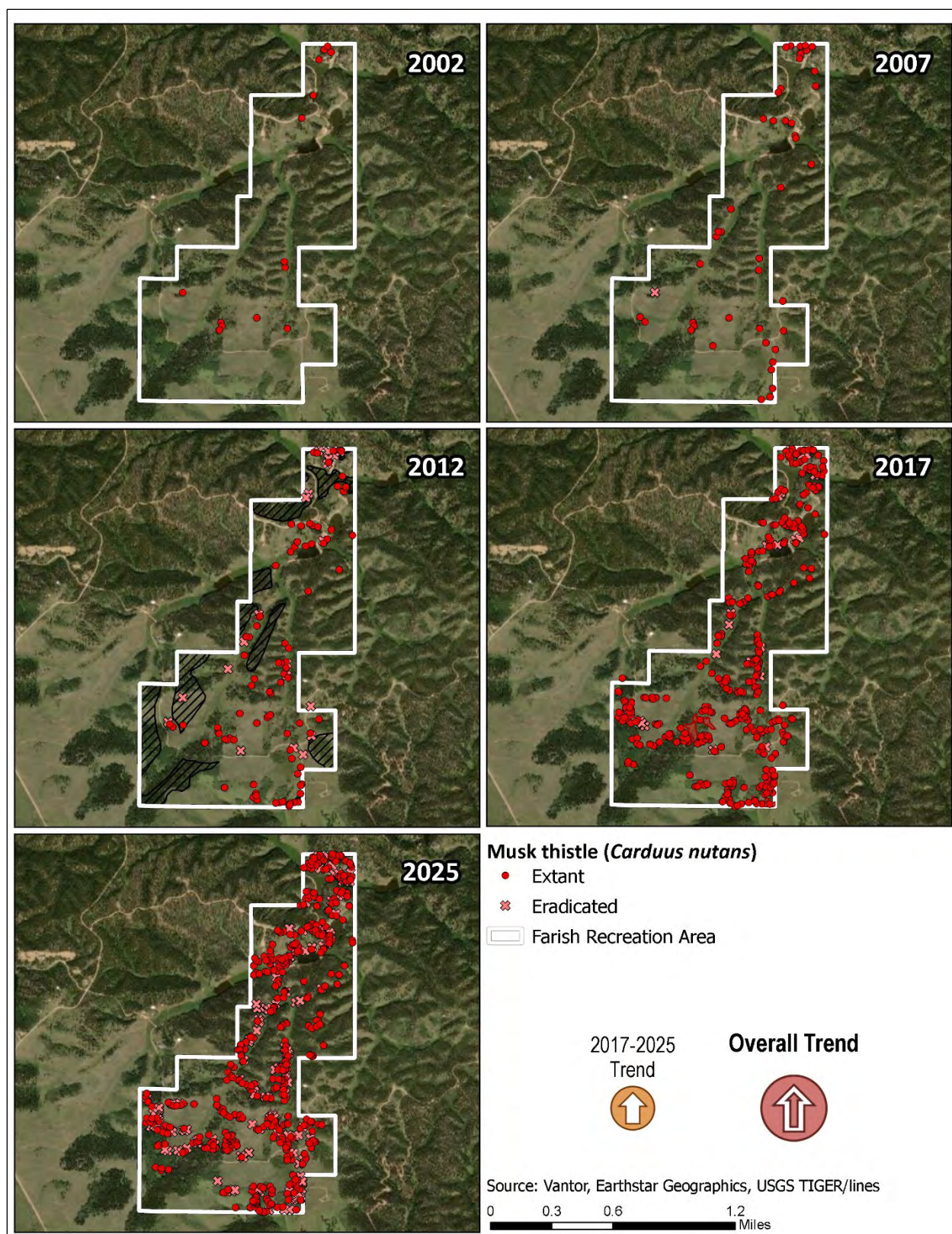
- In 2016–2017, there was an increase in the number of plants. The overall trend is decreasing but musk thistle has been increasing since 2013 and could be related to precipitation and inappropriate herbicide applications.
- Basewide mapping in 2018 with ten photo monitoring plots updated. Weed survey shows an increase in musk thistle, while photo plots show a decrease.
- In 2024, basewide mapping at the Academy showed a slight reduction in the number of individuals, occupied acres, and extant features for musk thistle, which is correlated with the spring and summer precipitation.
- In 2025, supplementary basewide mapping was performed to capture select areas that were not mapped in the 2024 basewide survey. Additionally, musk thistle was mapped property-wide at the Farish.



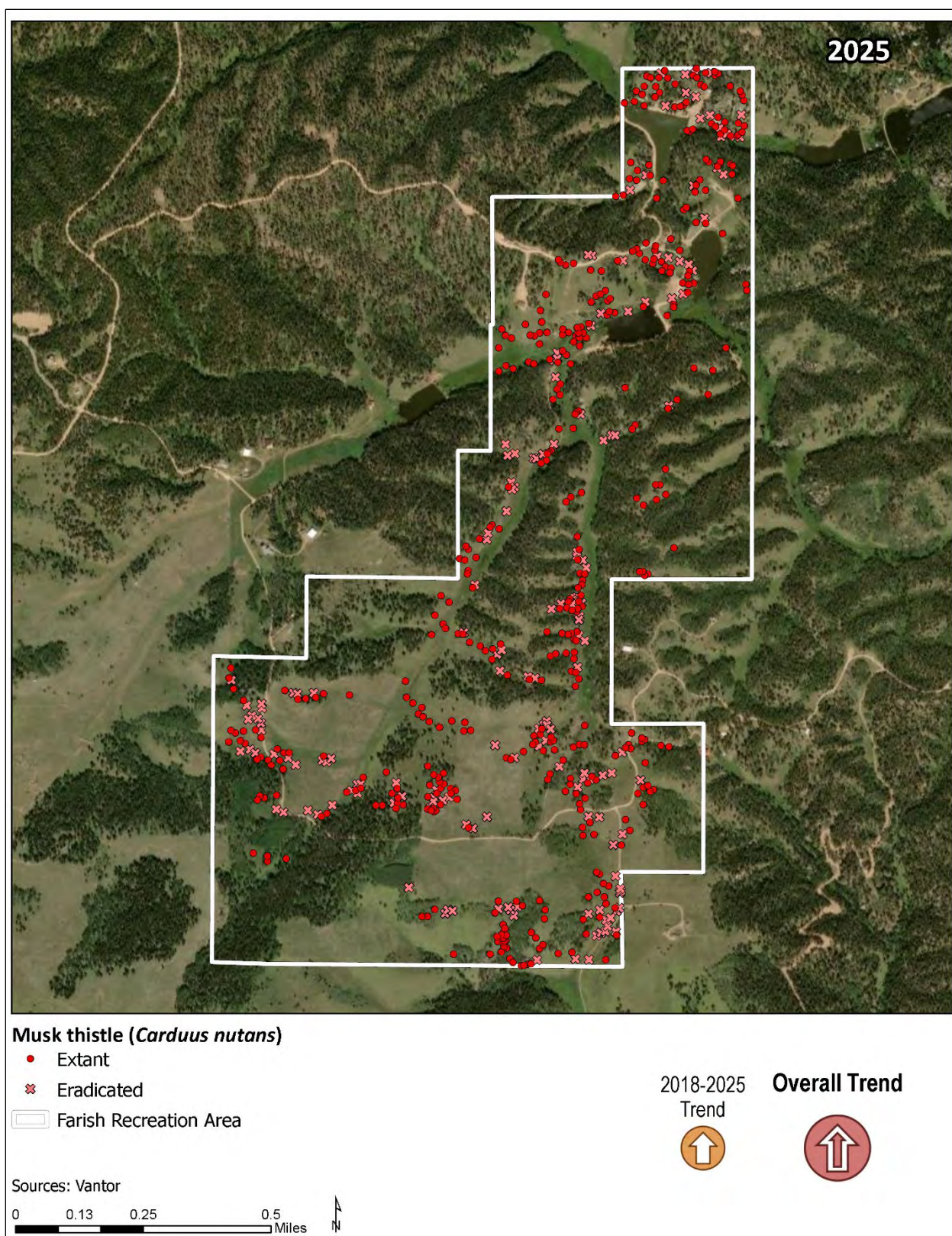
Map 6. Distribution of musk thistle at the Academy from basewide weed surveys (2002, 2007, 2012, 2018, and 2024-2025).



Map 7. Distribution of musk thistle at the Academy from basewide weed survey in 2024-2025.



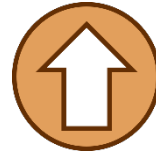
Map 8. Distribution of musk thistle at the Farish during survey years 2002, 2007, 2012, 2017, and 2025.



Map 9. Distribution of musk thistle at the Farish in 2025.

Diffuse, Spotted, and Hybrid Knapweeds (*Centaurea diffusa*, *C. stoebe* ssp. *micranthos*, & *C. × psammogena*)

Change from 2018–2025: Increasing
Management Goals: Suppression
State List: B



- Short-lived perennials or biennials, which reproduce only by seeds (Jacobs, 2008; Natural Resources Conservation Service [NRCS], 2006).
- Seeds germinate in the spring or fall and anytime during the growing season with disturbance (Beck, 2013b; Jacobs, 2008).
- Environmental disturbance promotes invasion (Beck, 2013b; NRCS, 2006).
- Seed longevity: 8–10 years (NRCS, 2006).
- Produces some allelopathic chemicals which may give it some competitive advantage (NRCS, 2006).



Figure 14. *Centaurea* spp. found at that Academy. *C. stoebe* ssp. *micranthos* flowering (top left), *C. diffusa* flowering (top center), *C. diffusa* budding (top right), *C. × psammogena* (bottom left), and *C. diffusa* (bottom right) – Photos by Robert Monahan, 2024.

2024–2025 Overall Mapping Results

In 2024, there was a basewide survey of the knapweeds (spotted, diffuse and hybrid) with supplementary mapping completed in 2025. Diffuse knapweed is by far the most common species of the knapweeds at the Academy, with around 73% of the total occupied acres of knapweeds, while spotted knapweed occupies about 26%, and the hybrid with less than 0.01% of the total occupied acres.

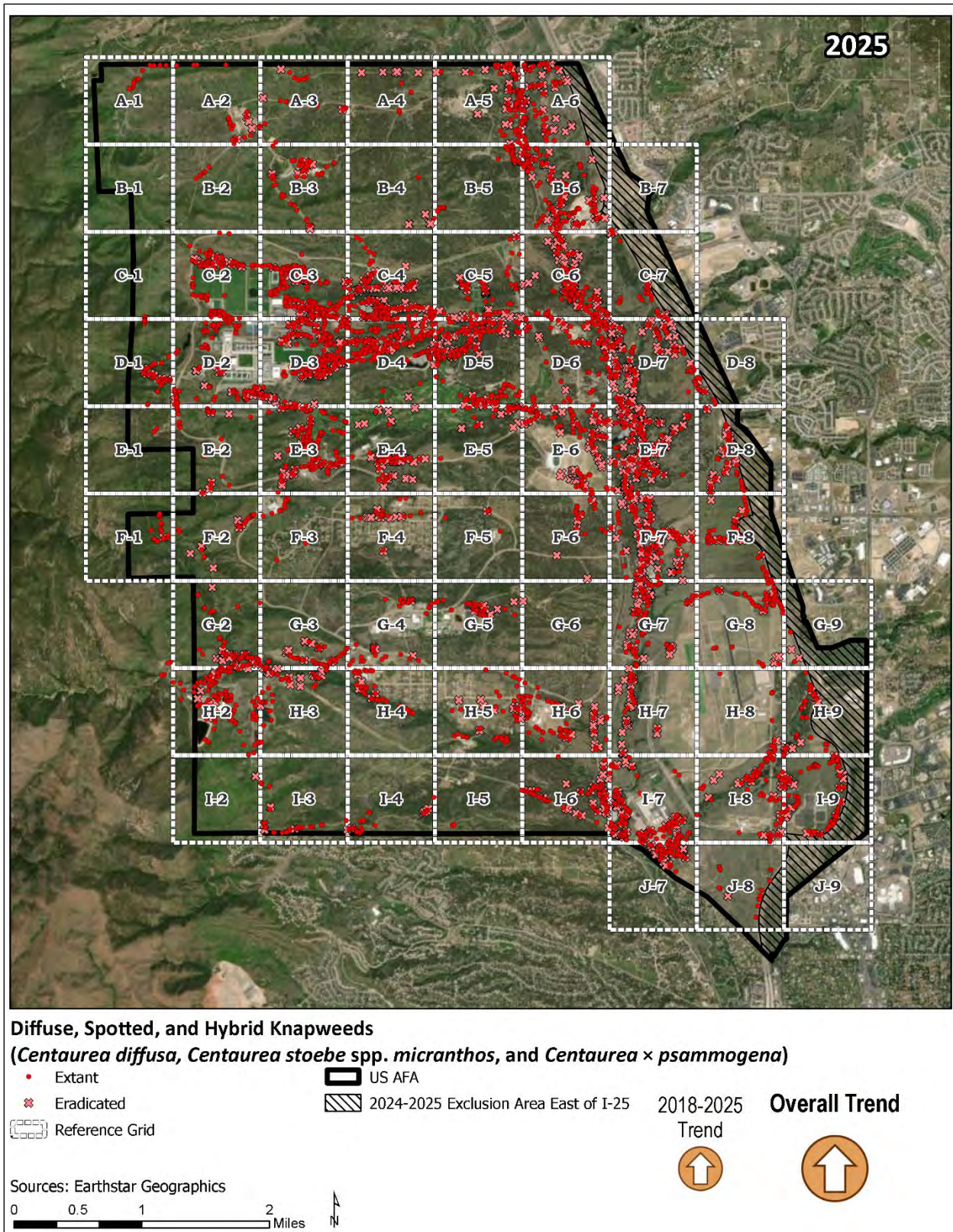
The data is reported below for all knapweeds and in separate sections for each of the three species of knapweeds. The acreage occupied by all knapweeds has increased by 16.6 acres since 2018 when it was at 226.42 acres, to the current 243.02 acres in 2025. (Table 15, Map 10).

Table 15. Diffuse, spotted, and hybrid knapweeds at the Academy in 2025.

Species	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
Diffuse	178.33	1,791,273	2,679	850
Spotted	62.43	569,760	1,090	351
Hybrid	2.25	7,550	260	215
All Knapweeds	243.02	2,368,583	4,029	1,416

Noxious weeds were not mapped east of I-25 in 2024 and 2025 due to ongoing construction. A total of 484 knapweed features which are east of I-25 were excluded from the 2024–2025 mapping and analysis.

The knapweeds at the Academy include diffuse knapweed (*Centaurea diffusa*), spotted knapweed (*Centaurea stoebe* ssp. *micranthos*), and their hybrid (*Centaurea x psammogena*). Combined these three species cover the largest occupied area of all mapped noxious weeds with 243 occupied acres and an estimated 2.37 million shoots at over four thousand features (Table 15, Map 10). Knapweeds are exceedingly difficult to eradicate once they are established if follow-up plantings of native grasses and forbs are not part of an integrated management plan. The seeds are persistent, they are transported easily by wind, animals, or by anthropogenic means. Knapweeds grow especially well in disturbed soils along roadsides or trails.



Map 10. Distribution of diffuse, spotted and hybrid knapweeds from basewide weed survey in 2024-2025.

Diffuse Knapweed (*Centaurea diffusa*) 2024–2025 Mapping Results

Diffuse knapweed increased between every base wide survey from 2002 to 2025. Although notably the increase has slowed from 2012 to 2018, and again from 2018 to 2025. In 2025 the occupied acres were roughly equal to the occupied area in 2018. The number of extant features increased by 91 features since 2018, but the number of shoots continues to grow in recent years (Table 16, and Map 11).

Table 16. All mapping of diffuse knapweed at the Academy.

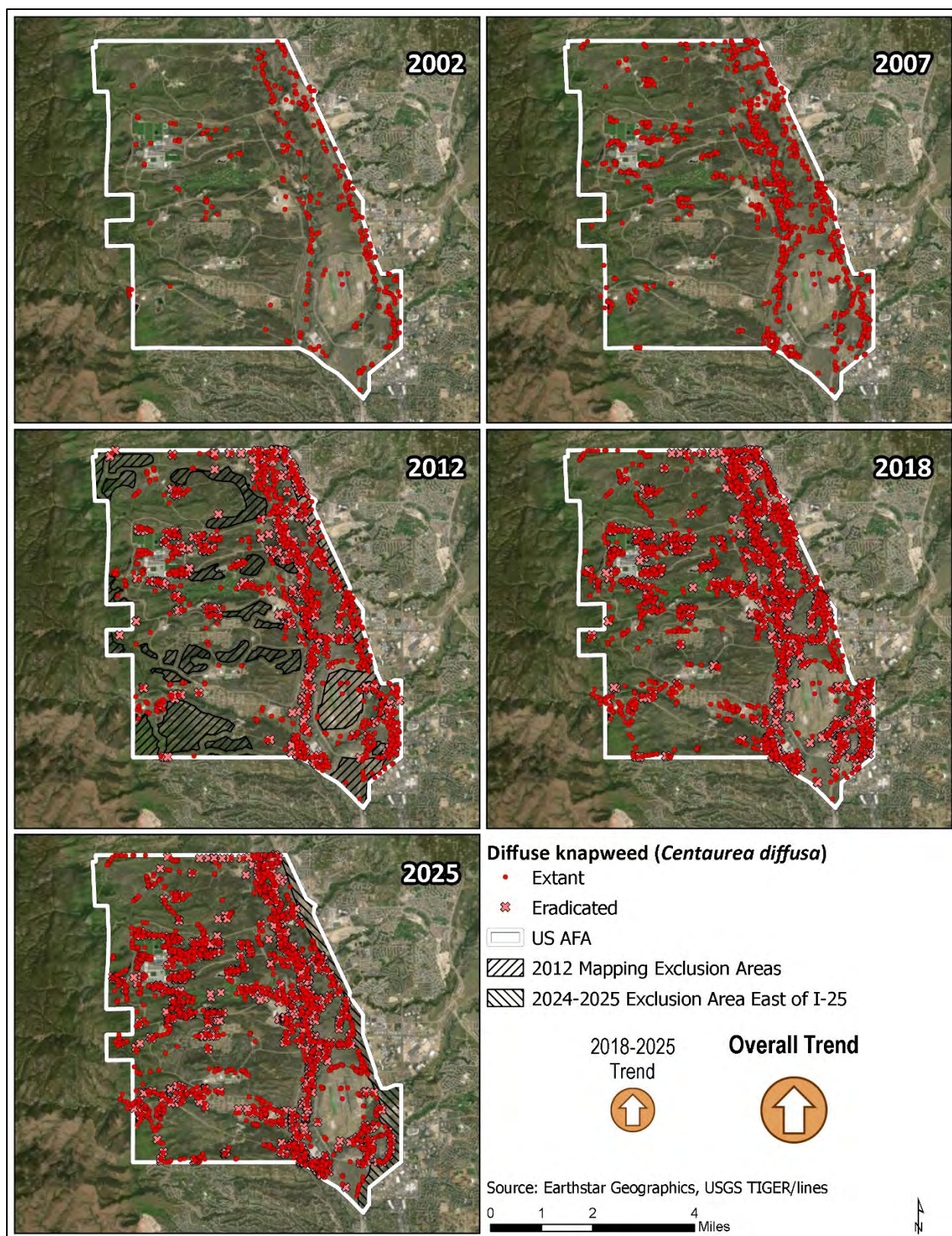
Year	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2002	56.37	141,805	328	---
2007	136.68	411,921	985	0
2012 ¹	117.41	1,352,457	1,329	406
2018	179.74	1,536,010	2,588	659
2024 ³	178.47	1,783,545	2,684	817
2025 ³	178.33	1,791,273	2,679	850

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Noxious weeds were not mapped basewide and were instead only mapped within designated mapping areas in 2012 (see Figure 3 for designated mapped areas).

² Noxious weeds were not mapped east of I-25 in 2024 due to ongoing construction. 412 diffuse knapweed features which are east of I-25 were excluded from the 2024 mapping and analysis.

³ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.



Map 11. Distribution of diffuse knapweed at the Academy from basewide weed surveys (2002, 2007, 2012, 2018, and 2024-2025).

Spotted Knapweed (*Centaurea stoebe* ssp. *micranthos*) 2024–2025 Mapping Results

Spotted knapweed increased between 2002 and 2007 mapping events but appears to have stabilized between 2007 and 2018 in occupied acres and the number of shoots appears to have stabilized around a half million. In 2024 and 2025, all metrics show a small increase since 2018 (Table 17, and Map 12).

Table 17. All Mapping of spotted knapweed at the Academy.

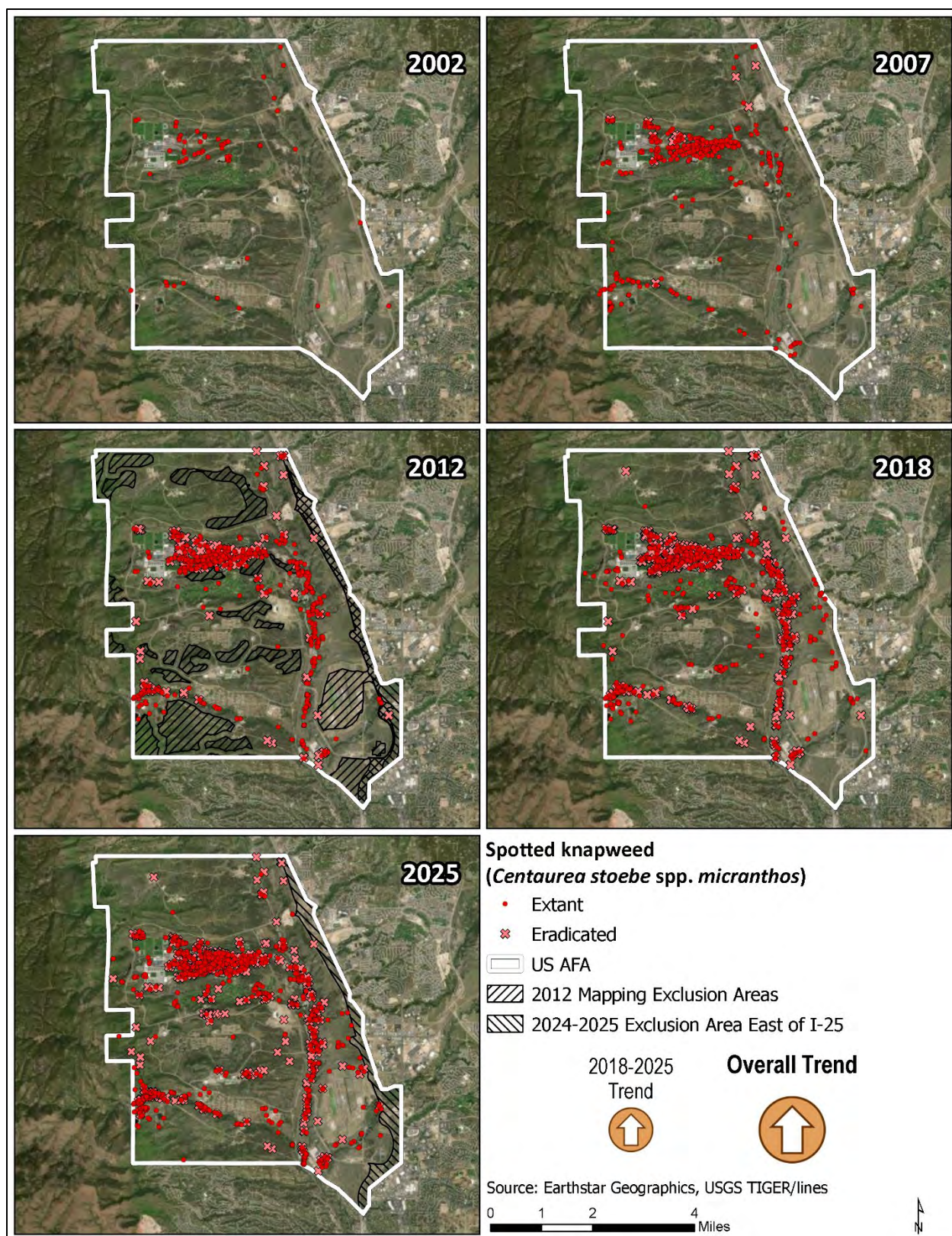
Year	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2002	4.67	3,485	54	---
2007	57.58	127,836	323	16
2012 ¹	53.08	543,353	569	156
2018	49.29	480,136	864	278
2024 ²	62.51	567,434	1,094	346
2025 ³	62.43	569,760	1,090	351

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Noxious weeds were not mapped basewide and were instead only mapped within designated mapping areas in 2012 (see Figure 3 for designated mapped areas).

² Noxious weeds were not mapped east of I-25 in 2024 due to ongoing construction. 15 spotted knapweed features which are east of I-25 were excluded from the 2024 mapping and analysis.

³ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.



Map 12. Distribution of spotted knapweed at the Academy from basewide weed surveys (2002, 2007, 2012, 2018, and 2024-2025).

Hybrid Knapweed (*Centaurea × psammogena*) 2024–2025 Mapping Results

The hybrid knapweeds were mapped with a similar occupied acres between 2007 and 2018 with a spike in 2012. The estimated number of shoots also spiked in 2012 with an overall increase since 2002. The occupied area and number of shoots in 2025 is lower than the 2018 figures, which may indicate that the populations have begun to stabilize (Table 18, and Map 13). It should be noted that hybrid knapweed is notoriously difficult to identify due to its ability to resemble either of the parent species.

Table 18. All Mapping of hybrid knapweeds at the Academy.

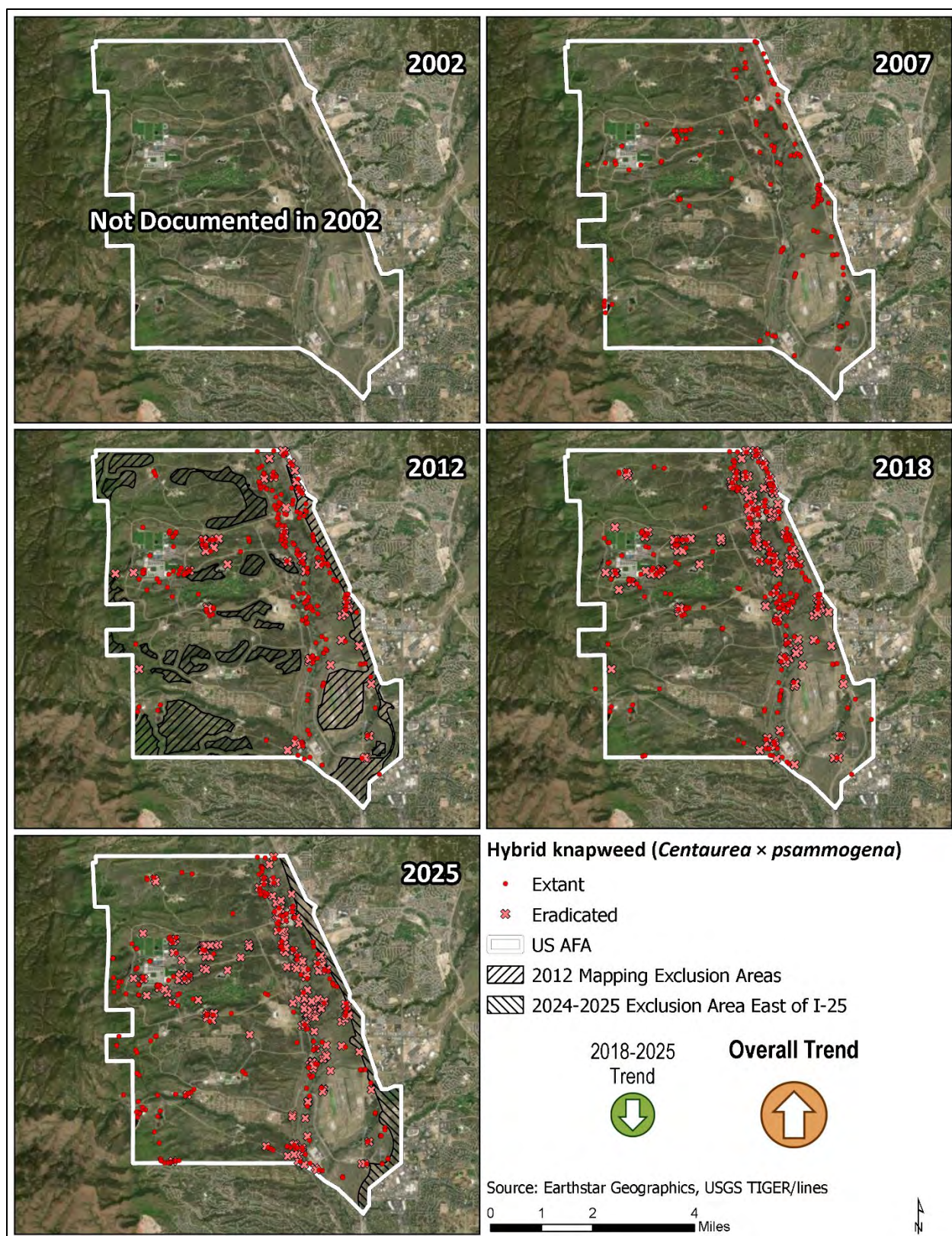
Year	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2002	---	---	---	---
2007	1.8	2,922	125	---
2012¹	5.98	43,104	248	54
2018	2.64	24,770	295	159
2024²	2.19	7,562	256	214
2025³	2.25	7,550	260	215

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Noxious weeds were not mapped basewide and were instead only mapped within designated mapping areas in 2012 (see Figure 3 for designated mapped areas).

² Noxious weeds were not mapped east of I-25 in 2024 due to ongoing construction. 57 hybrid knapweed features which are east of I-25 were excluded from the 2024 mapping and analysis.

³ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.



Map 13. Distribution of hybrid knapweed at the Academy from basewide weed surveys (2002, 2007, 2012, 2018, and 2024-2025).

Recommendations

There has been a fairly aggressive chemical treatment program for knapweeds at the Academy; however, they continue to increase across the base. Consideration of a new treatment strategy for knapweeds using site plans is recommended. There is evidence that herbicides can be effective for short-term control, but there are significant risks to both humans and the environment (Jacobs, 2008; NRCS, 2006). Research indicates herbicide treatments alone will not eliminate knapweeds (Beck 2013a) and if only chemical treatments are used to suppress plants the end result is an increase in weed cover (Beck, 2013b; Pearson & Ortega, 2009). To be most effective, treatments must not affect nearby native species or cause soil disturbances. Herbicides can cause soil disturbance by increasing bare ground, changing the pH and the balance of soil organisms, and impacting nearby native forbs and woody species (Nicholas et al., 2008). Partial treatments appear to be inevitable under current practices. If there is no plan to restore the chemically or mechanically treated areas with native plantings, it may be prudent to discontinue herbicide applications in natural areas where native plants need to be protected (Smith et al., 2015). Replanting or restoration should be part of the plan to treat dense stands of weeds, especially in wildlands (Jacobs, 2008; NRCS, 2006).

History of Sampling and Treatment:

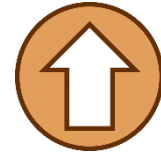
- Census mapping for knapweed distribution across the Academy property was conducted in 2002, 2007, and 2012.
- Ten CNHP permanent plots were established in 2012.
- In 2013, the diffuse and spotted knapweeds were combined into a hybrid complex “knapweeds”.
- In 2013, knapweeds, regardless of treatment, experienced a decrease in frequency, density, and cover, most likely due to the drought. (All of the 2013 plots were measured before the drought ended).
- TAMU established a new biocontrol plot, DK kwy83 in 2013.
- 2014 plot data show a decreasing overall trend, with the density showing a significant increase (Rondeau and Lavender-Greenwell 2013). All biocontrol plots were treated with herbicide and were not monitored by TAMU in 2014.
- In 2015, the plots were stable with a slight overall decrease. Only nine of the ten plots were monitored (plot CEDI4-2 was incorporated into the nearby golf course). One plot (CEDI3-5) showed an increase despite being treated with herbicide. The biocontrol plots were all treated with herbicides and 2015 results

show stable to slightly decreasing trends. One plot showed an overall decrease (DK hwy83) and KWmonck showed a slight decrease; this plot was impacted by wood dumping that buried about five percent of the plot and included six of the monitoring points for the plot in 2015.

- Frostweed (*Crocanthemum bicknellii*) was observed in monitoring plots in 2015 –2017. This species is considered to be critically imperiled in Colorado with only a few known populations in the state.
- In 2016, KWmonck and DK hwy83 were discontinued. The total number of plots surveyed was twelve. The overall trend across all plots between 2012–2106 was stable to decreasing.
- In 2017, 12 total plots were surveyed with on overall stable trend. The biocontrol plot data will be kept separate for a couple of years because of the herbicide application observed in 2014.
- In 2018, seven of the twelve knapweed plots were monitored: CEDI –1 & 3, CEMA 1 & 4 were not monitored. CEDI 5 was discontinued because of issues keeping the permanent markers in place (plot was set up in a flood zone).
- In 2024, basewide mapping at the Academy showed a moderate increase in the total number of individuals and occupied area. The knapweed plots are no longer being monitored.
- In 2025, supplementary basewide mapping was performed to capture select areas that were not mapped in the 2024 basewide survey.

Canada Thistle (*Cirsium arvense*)

Change from 2018–2025: Increasing
Management Goals: Suppression
State List: B



- Perennial (Beck, 2013a; Henderson et al., 2025)
- Horizontal and vertical root system (Beck, 2013a, Henderson et al., 2025)
- Reproduction from root buds and seeds (Henderson et al., 2025)
- Seed longevity 22 years with deep burial promoting longevity (Beck, 2013a)
- Susceptible to shading and inundation.
- Biological agents available, three insect species which have shown poor control effects of any kind (Beck, 2013a), and some promising suppression effects with rust fungus (*Puccinia punctiformis*) (Henderson et al., 2025)



Figure 15. (left) *Cirsium arvense* flowering near Monument Creek, 2024; (right) A population of *Cirsium arvense* in Jacks Valley with all white flowers, 2025 – Photos by Robert Monahan

Air Force Academy 2024–2025 Mapping Results

At the Academy, the mapping data for Canada thistle shows an increase in all metrics from 2018 to 2025. Canada thistle occupies the second largest number of

acres of any weed species at 123 acres in 2025, just behind the knapweeds. Canada thistle has an estimated 2.6 million shoots in 2025 at 1,735 sites (Table 19, Map 14, and Map 15).

Table 19. All mapping of Canada thistle at the Academy.

Year	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2002	101.36	529,103	543	---
2007¹	93.62	400,021	563	0
2012¹	95.95	1,169,173	963	232
2018	104.01	1,934,852	1,466	467
2024²	123.48	2,658,856	1,741	512
2025³	123.63	2,655,257	1,735	531

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Noxious weeds were not mapped basewide and were instead only mapped within designated mapping areas in 2007 and 2012 (see Figure 3 for designated mapped areas).

² Noxious weeds were not mapped east of I-25 in 2024 due to ongoing construction. 60 Canada thistle features which are east of I-25 were excluded from the 2024 mapping and analysis.

³ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

Farish Recreation Area 2025 Mapping Results

At the Farish, the mapping data for Canada thistle shows an increase in occupied acres and number of extant features but a decrease in the number of individuals from 2017 to 2025. Canada thistle has an estimated 131 thousand shoots in 2025 at 1,735 sites (Table 20, Map 16, Map 17).

Table 20. All mapping of Canda thistle at the Farish.

Year	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2002	0.23	3,488	8	---
2007	1.55	14,734	23	1
2012	1.27	24,082	35	8
2017	3.96	169,599	74	10
2025	4.80	131,867	124	39

Farish wide weed mapping was performed in 2002, 2007, 2012, 2017, and 2025, which are the shaded rows.

Recommendations

Consider a site plan before attempting to control Canada thistle in wildlands at the Academy. The protection of the rare amphibian species and rare plant species should be considered in future management since both were documented in the Canada thistle weed plots in previous years and in 2024. A state vulnerable, Colorado species of concern, USFS and BLM sensitive amphibian species, northern leopard frog (*Lithobates pipiens*), was seen in numerous locations along Monument Creek and Kettle Creek in 2024. An uncommon plant species (CNHP watchlist) carrion-flower (*Smilax lasioneura*) has also observed growing alongside Canada thistle.

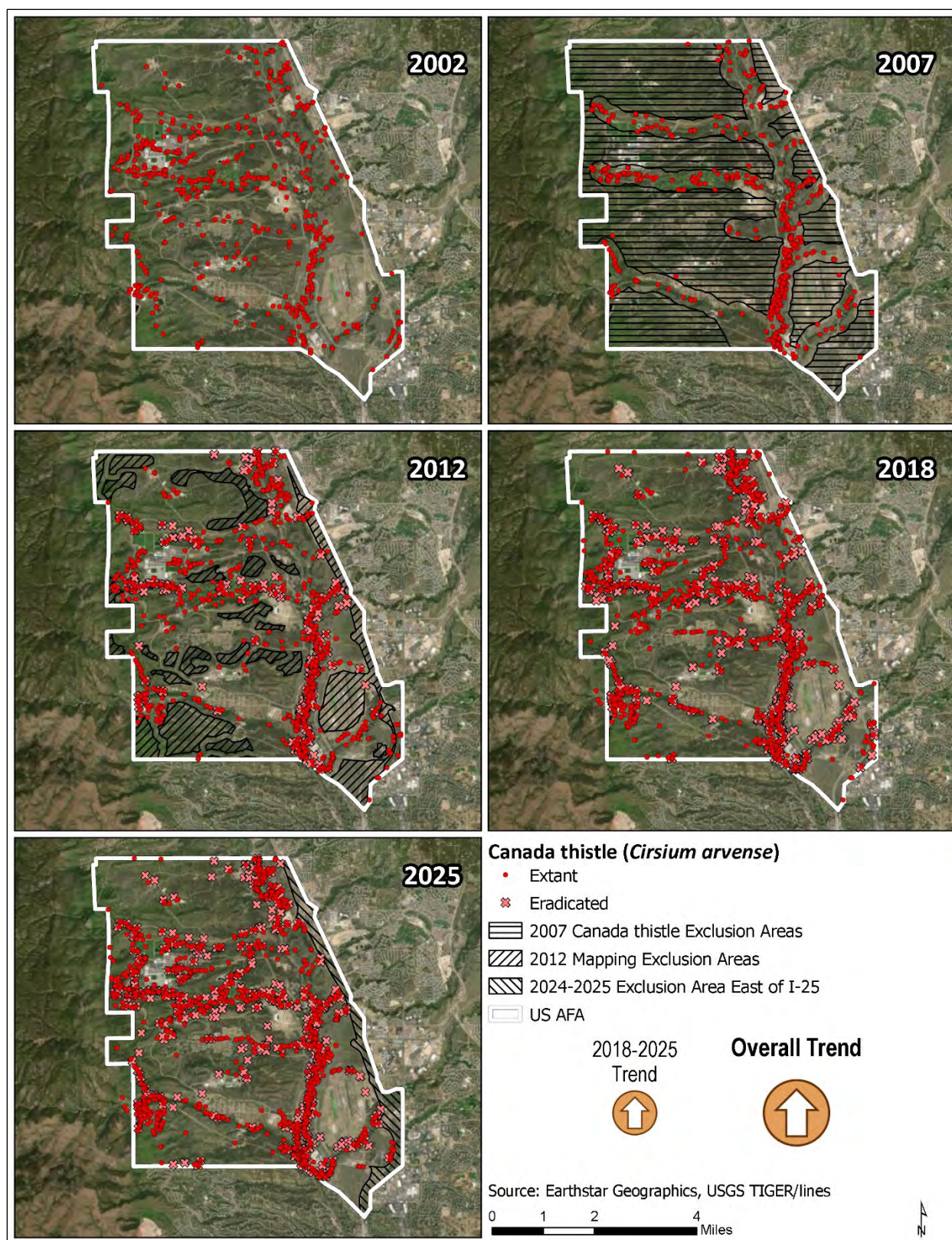
Rust fungus (*Puccinia punctiformis*) inoculum has shown some promising suppression effects on Canada thistle (Henderson et al., 2025), and should be considered as part of a broader plan to control the species. It should be noted when considering future treatments of Canada thistle that a number of studies are indicating that herbicides used in wildlands have not been successful at controlling Canada thistle without some other integrated management strategy (Beck, 2013a; Pearson et al., 2016). A study in Rocky Mountain National Park demonstrated that weed management practices including both chemical and mechanical treatments resulted in impacts to soils, soil biota and native plant species that were as damaging as the impacts from the Canada thistle (Pritekel et al., 2006). This calls into question the use of herbicides or any treatments that damage soils in systems where the protection of native vegetation is critical. Encouraging the biocontrol activities and protecting the surrounding landscape from disturbances while monitoring for expansion combined with a site plan for any active management are highly recommended for areas with SWMAs. This will help document what is working to decrease weeds. Since most activities that impact the above ground portions of the plant cause the underground root buds to be stimulated the actual footprint of Canada thistle can increase with treatments and may be best left untreated if there is no plan for restoration in dense areas.

History of Sampling and Treatments:

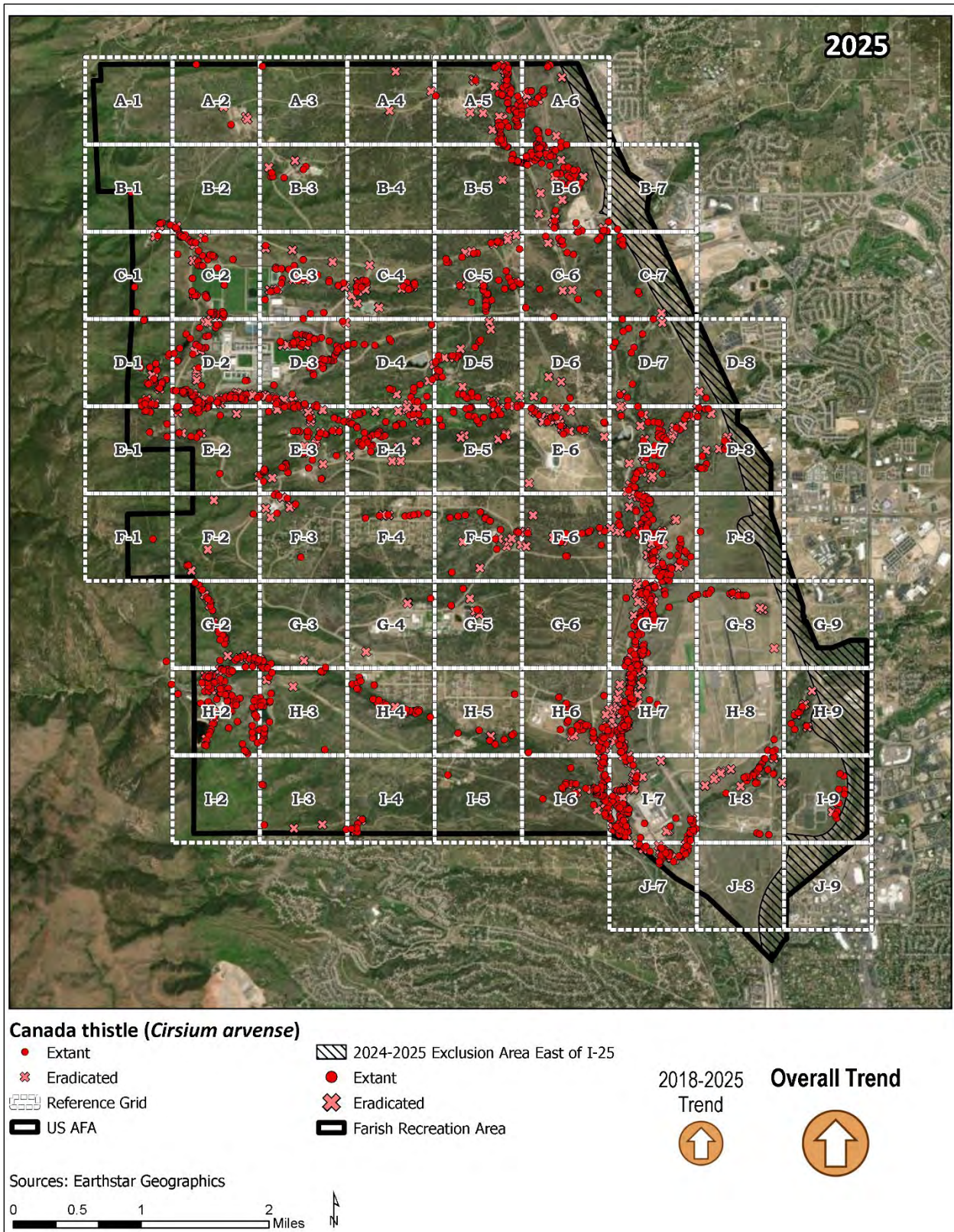
- In 2012, eight permanent plots were set up by CNHP.
- Census mapping for Canada thistle distribution across the Academy property was conducted in 2002, 2007, and 2012.
- Plots were monitored in 2012 and 2014.
- Although 2014 plot data trends are decreasing, it is worth noting that in 2012 we conducted weed mapping of Canada thistle. The number of extant

features significantly increased between 2007 and 2012 (Lavender-Greenwell and Rondeau 2013).

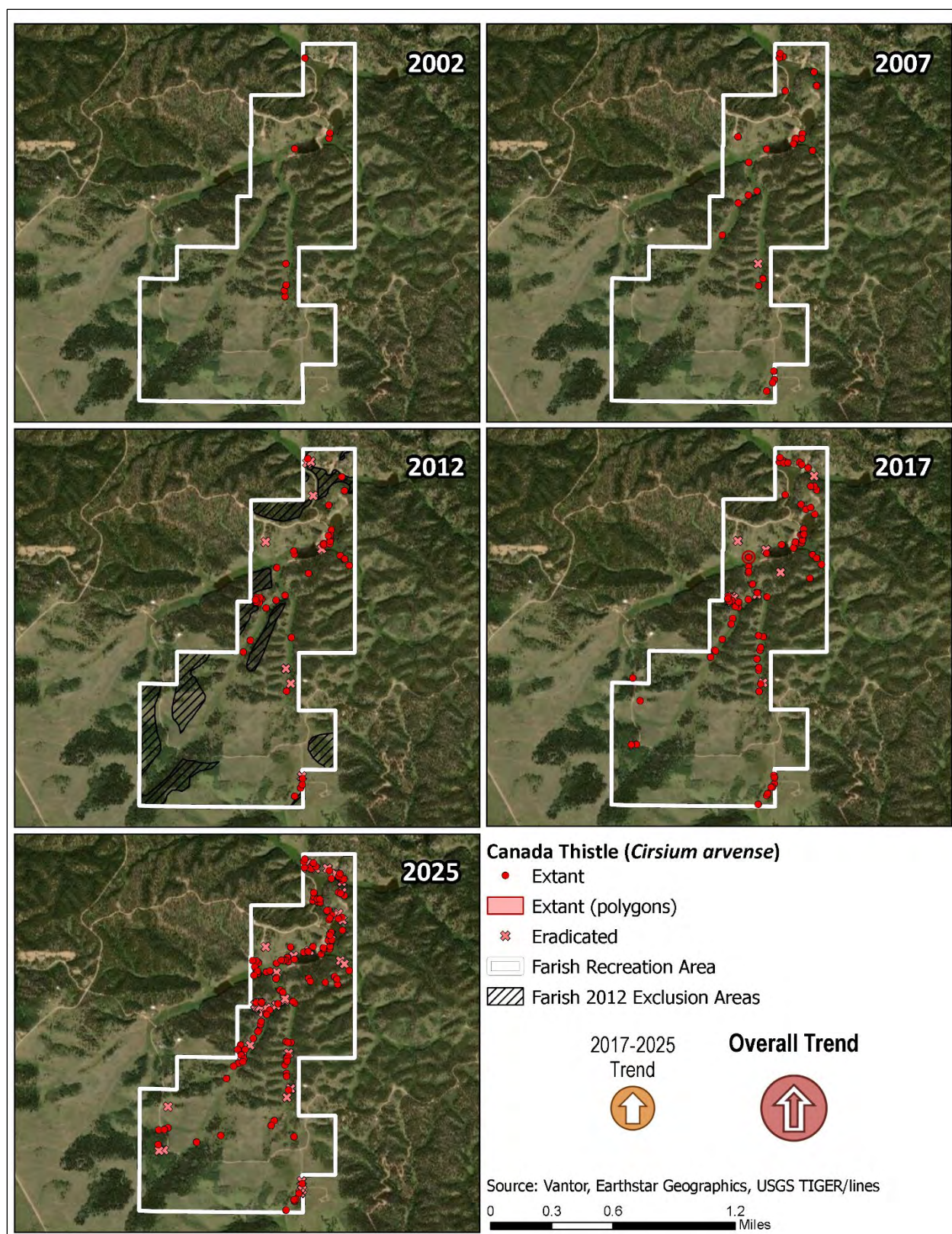
- All plot metrics indicated a stable to decreasing trend from 2012–2015. Seven of eight permanent plots were monitored with the exception of CIAR4–6 (flooded); one biocontrol plot (CTploop) was added by CNHP in 2015. Biocontrol and insect and animal browse were noted on Canada thistle in six plots. A tracked amphibian species (Northern Leopard Frog) and a CNHP watch listed plant species (carrion-flower) were both observed in Canada thistle monitoring plots in 2015. Plots were partially treated with herbicide.
- All metrics indicated a decreasing to stable trend for 2016. Seven of eight plots were sampled with CIAR4–6 flooded for the second year in a row. CTploop biomonitoring plot was monitored and a new plot CTice1 was added to bring the total plot number to ten to strengthen statistics. CTice2 and CTkettle are discontinued. Both biomonitoring plots showed a decrease for all metrics greater than one average standard deviation from 2012–2016. Biocontrol organisms were noted in seven plots in 2016 compared to only three in 2015. No plots were treated with herbicide in 2016.
- In 2017, 10 plots were monitored and show an overall decreasing trend compared to 2012. Five plots showed evidence of biocontrol organisms.
- In 2018, there was basewide noxious weed mapping and eight permanent plots were monitored for Canada thistle. Two plots were discontinued in the forested area on the west side as the vegetation was getting too dense to use the monitoring plot method that is suited to grasslands or shrublands.
- In 2024, basewide mapping at the Academy showed that Canada thistle increased according to all metrics. Permanent plots are no longer being monitored.
- In 2025, supplementary basewide mapping was performed to capture select areas that were not mapped in the 2024 basewide survey. Additionally, Canada thistle was mapped property-wide at the Farish.



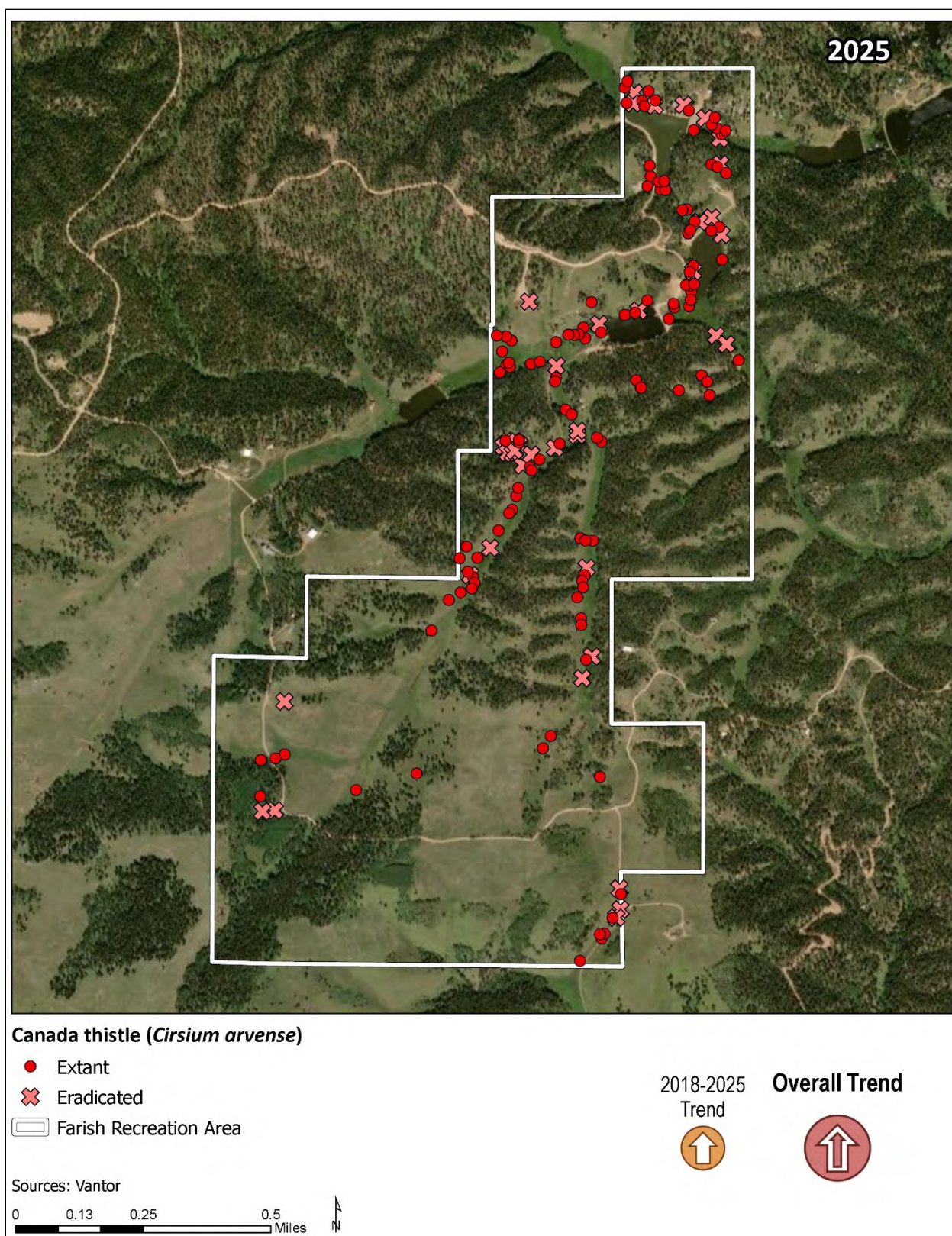
Map 14. Distribution of Canada thistle at the Academy from basewide weed surveys (2002, 2007, 2012, 2018 and 2024-2025).



Map 15. Distribution of Canada thistle at the Academy from basewide weed survey in 2024-2025.



Map 16. Distribution of Canada thistle at the Farish during survey years 2002, 2007, 2012, 2017, and 2025.



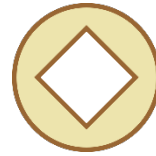
Map 17. Distribution of Canada thistle at the Farish in 2025.

Bull Thistle (*Cirsium vulgare*)

Change from 2018–2025: Stable

Management Goals: Suppression

State List: B



- Biennial or monocarpic perennial (Klinkhamer & Jong, 1993; Piscoran et al., 2024)
- Reproduction by seed (Piscoran et al., 2024)
- Often confused with native thistles.
- Distinct pustulate and hispid (stiff bristly) hairs on leaf surface can be used to distinguish this species from native thistles even when no flowers are present.
- Clipped flower heads can still produce seeds.
- Lower leaves with white hairs, upper surface has spines.
- Taproot as deep as 2.3 feet (Klinkhamer & Jong, 1993).
- Seed longevity of 3 or more years (Piscoran et al., 2024)



Figure 16. *Cirsium vulgare* found at the Academy in 2024 – Photos by Robert Monahan

2024–2025 Mapping Results

The number of bull thistle shoots and extant features have increased since 2002 but has stabilized since 2018 at around four acres of occupied area and around 16,000 shoots (Table 21, Map 18, and Map 19). Spring and summer precipitation are correlated with occupied acres of bull thistle from 2007 to 2025 (Figure 17).

Table 21. All Mapping of bull thistle at the Academy.

Year	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2002¹	5.54	596	73	---
2007	6.46	4,412	131	0
2012²	1.23	4,154	210	79
2018	4.04	15,656	417	171
2024³	3.93	16,351	378	318
2025⁴	3.93	16,406	386	319

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹2002 values from field notes, not adequately mapped in GIS.

²Noxious weeds were not mapped basewide and were instead only mapped within designated mapping areas in 2012 (see Figure 3 for designated mapped areas).

³Noxious weeds were not mapped east of I-25 in 2024 due to ongoing construction. 7 bull thistle features which are east of I-25 were excluded from the 2024 mapping and analysis.

⁴Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

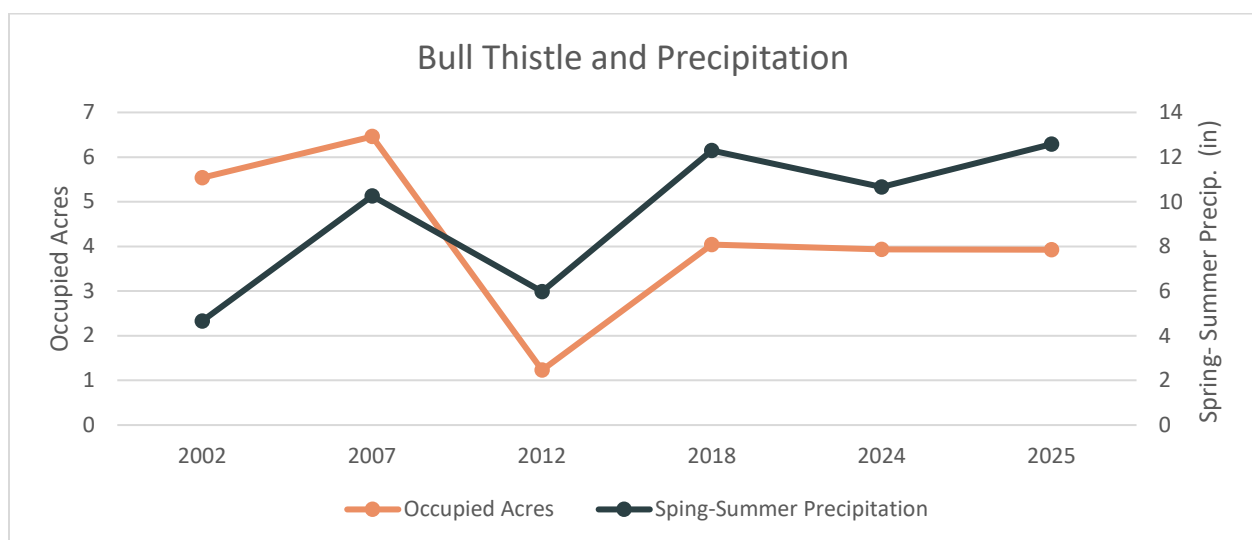


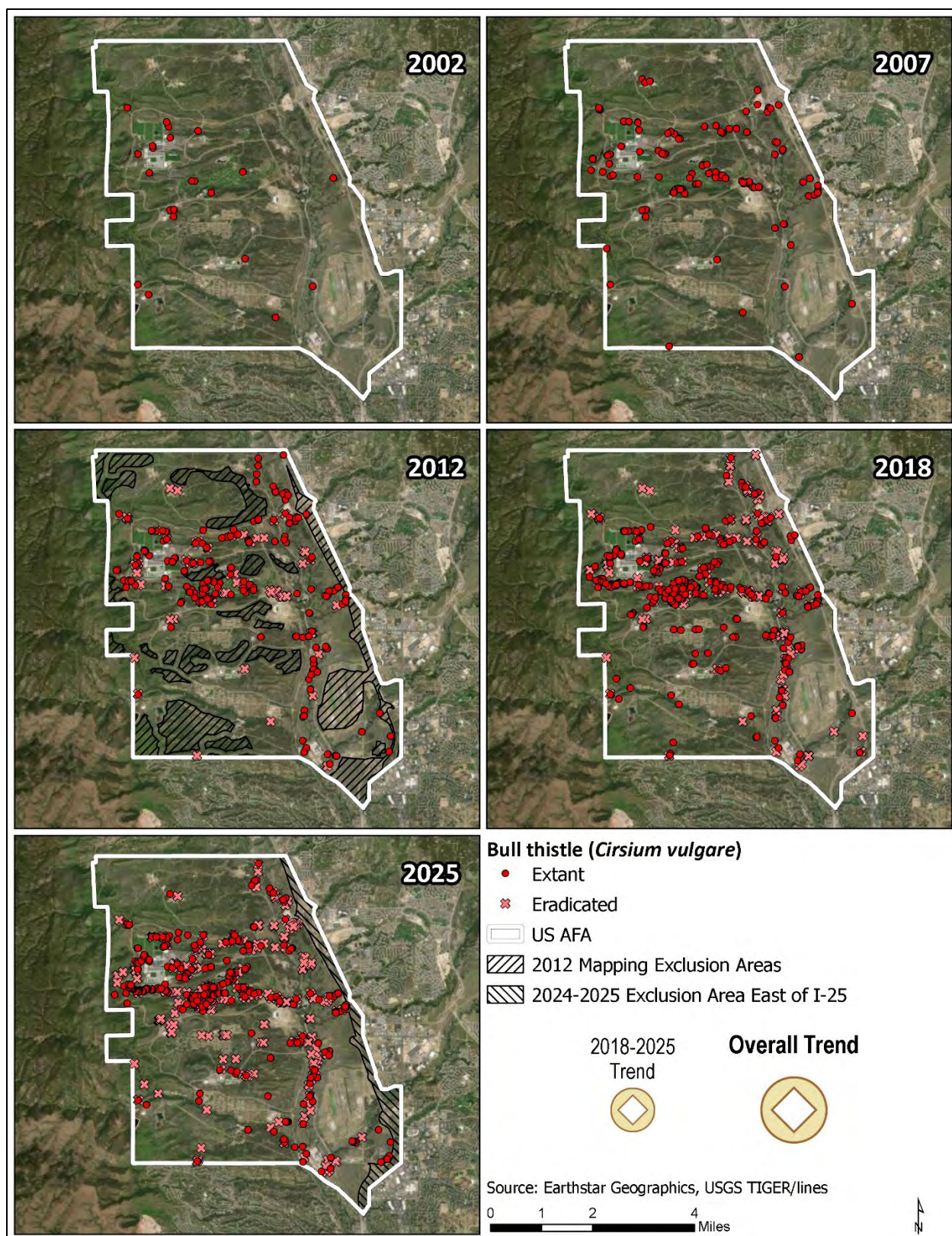
Figure 17. Comparison of spring-summer precipitation and occupied acres of bull thistle at the Academy.

Recommendations

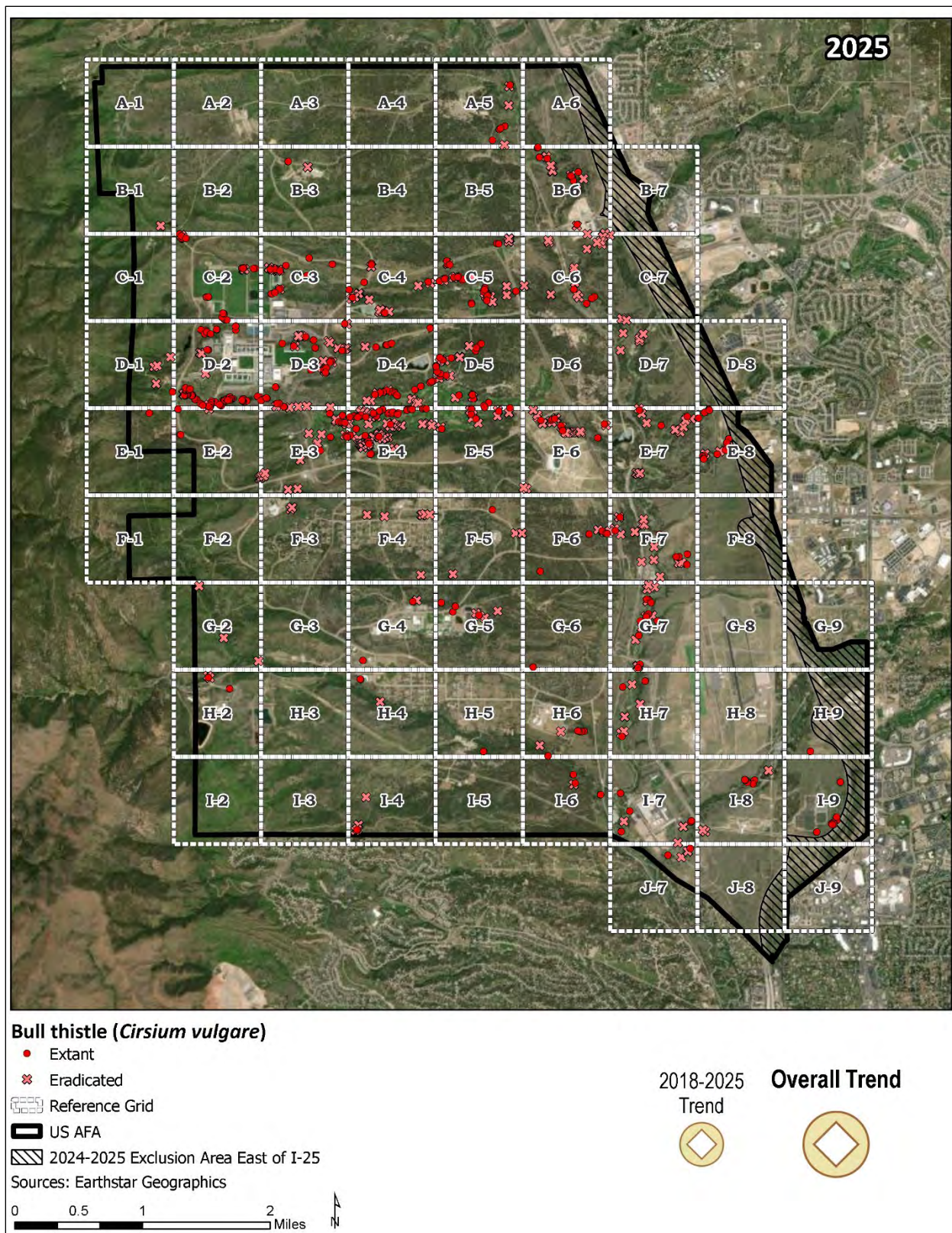
Years that have wet spring and summer rains tend to show increases in populations. This species can be treated by severing the plant below the root crown (cut below the soil surface). The best time to do this is in the spring or before the plants bolt. Bolted stems need to be removed if they have flower or seed heads. Since these plants are often found in moist to wet habitats, this is the preferred method. Chemical treatments in wetlands are not recommended, especially in the undeveloped areas of the Academy. Riparian areas are a disturbance dominated habitat especially at the Academy where unnatural flows occur along many of the major drainages that provide a constant source of seeds from the east and west sides of the Academy. Even if control could be achieved in a single year, the chance of reintroduction is exceedingly high in these areas. If treatments are to occur, they should have a site plan with a focus on what the site will look like when the treatment is undertaken, why it needs to occur and the follow-up and monitoring activities that will occur. In addition, the site should be a workable sized area with considerations for re-seeding as necessary and the utilization of techniques appropriate for wetlands.

History of Sampling and Treatment:

- Bull thistle was mapped as part of the basewide surveys in 2002, 2007, 2012, 2018, and 2024. Portions of its distribution in 2002 were only captured in field notes and not mapped.
- In 2025, supplementary basewide mapping was performed to capture select areas that were not mapped in the 2024 basewide survey.



Map 18. Distribution of bull thistle at the Academy from basewide weed surveys (2002, 2007, 2012, 2018, and 2024-2025).



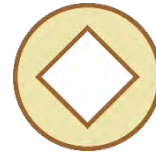
Map 19. Distribution of bull thistle at the Academy from basewide weed survey in 2024-2025.

Houndstongue (*Cynoglossum officinale*)

Change from 2024–2025: Stable

Management Goals: Eradication/Suppression

State List: B



- Biennial, short-lived perennial (Zouhar, 2002b)
- Not strictly monocarpic, can flower 1–3 years (Zouhar, 2002b)
- Reproduction only by seed, and seed longevity is 2–3 years (Zouhar, 2002b)
- Seedlings cluster in high densities around parent plant (Zouhar, 2002b)
- Thick, black, woody taproot
- Several rosettes can be linked to a single plant (Zouhar, 2002b)
- Velcro®-like nutlets (seeds) allow transport by animals.
- Seeds are sensitive to precipitation levels, negative correlation on dry years (Zouhar, 2002b)
- Plants thrive in disturbances and open dry ground caused by grazing and other soil disturbances that reduce competition from other plants (Zouhar, 2002b)



Figure 18. *Cynoglossum officinale* found at the Air Force Academy in 2024. A bolted adult plant (left), a first-year rosette (center), and a flowering stalk (right) – Photos by Robert Monahan

2025 Mapping Results

The houndstongue population at the Academy appears to have stabilized at around 11,000 individuals since last year. The number of mapped shoots decreased by around 2,000 from 2024 to 2025, which may be due to aggressive manual treatments carried out in 2024. Fifty-three sites were eradicated in 2025 (Table 22). The long-term trend though shows houndstongue is increasing across the Academy (Table 22, Figure 19, Map 20, Map 21, and Map 22). The largest increases in the number of individuals have happened in 2018 and 2024 when basewide mapping occurred. This indicates that the increases are from the discovery of new populations.

Table 22. Mapping of houndstongue at the Academy.

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002	---	---	---	---
2007	---	---	---	---
2009	0.09	95	8	0
2010	0.02	11	1	6
2011	<0.01 (10 m ²)	21	2	6
2012 ¹	0.01	70	3	9
2013	0.05	48	7	8
2014	0.04	102	8	8
2015	0.20	534	22	11
2016	0.20	480	22	14
2017	0.41	787	26	13
2018	0.51	4,514	50	22
2019	0.62	3,056	57	26
2020	0.65	3,691	49	35
2021	0.83	4,567	65	28
2022	---	---	---	---
2023	1.28	4,041	79	30
2024 ²	2.31	12,646	119	36
2025 ³	2.29	10,761	109	53

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Noxious weeds were not mapped basewide and were instead only mapped within designated mapping areas in 2012 (see Figure 3 for designated mapped areas).

² Noxious weeds were not mapped east of I-25 in 2024 due to ongoing construction. 5 houndstongue features which are east of I-25 were excluded from the 2024 mapping and analysis.

³ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

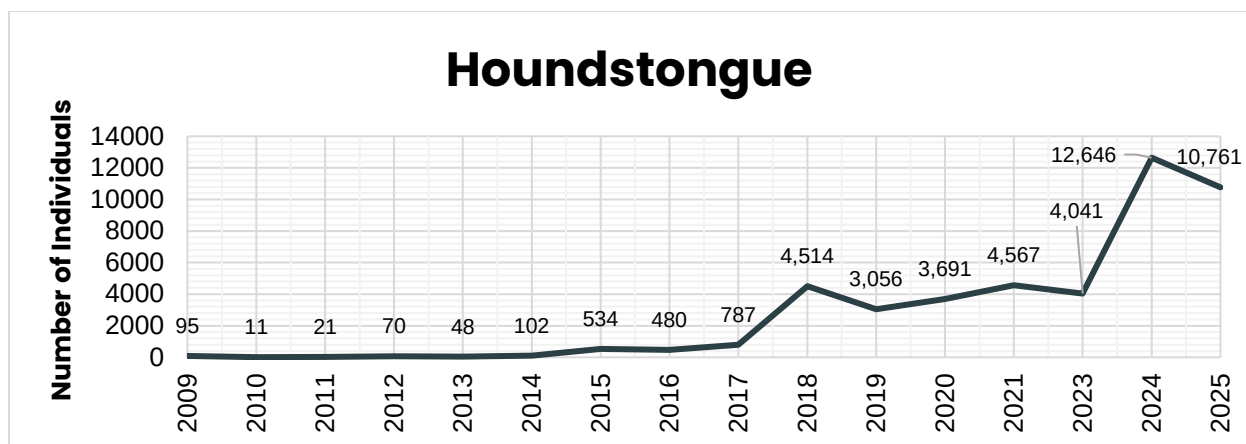


Figure 19. Number of houndstongue individuals mapped during the first pass, 2009-2025.

2025 Treatment

In 2025, 2,216 houndstongue plants were treated (Table 23). A substantial portion of individuals were found in Jack's Valley (Figure 20), near the wastewater treatment plant, on the forested cliffs on the eastern side of Monument Creek (Grid G-7, Map 22), and along Ice Lake Road. Several areas were targeted for treatments throughout the season.

Table 23. Monitoring and treatment of houndstongue sites at the Academy in 2025.

Pass & Year	# Site Visits	# Shoots Mapped	# Manually Treated Shoots	# Sites with Plants	# Sites without Plants
2025 Pass 1	106	3,752	1,912	65	41
2025 Pass 2	19	571	304	17	2
2025 Total	125	4,323	2,216	---	---
2021	128	5,330	3,840	---	---
2022	---	---	---	---	---
2023	142	5,196	3,865	---	---
2024*	179	13,613	7,826	---	---
2025	125	4,323	2,216	---	---

* Noxious weeds were not mapped east of I-25 in 2024 due to ongoing construction. 5 houndstongue features which are east of I-25 were excluded from the 2024 mapping and analysis.

One of the sites targeted for multiple treatments was Jack's Valley East which has several rare plant species within a unique wetland seep. In 2025, a visit was made in July to manually remove all of the houndstongue plants found within Jack's Valley East and a second visit was made in August. In total 635 individuals were treated at Jack's Valley East in 2025 which is down from the 1,516 individuals treated

in 2024. Houndstongue in this area grow mostly in the open where all the individuals can be easily treated, but a sizable portion of the population grows in the thickets of willows and shrubs at the bottom of the seep. At least some of the houndstongue in the thickets is able to go to seed each year. Containment of houndstongue to the thickets and eradication satellite locations is a feasible objective for this population.

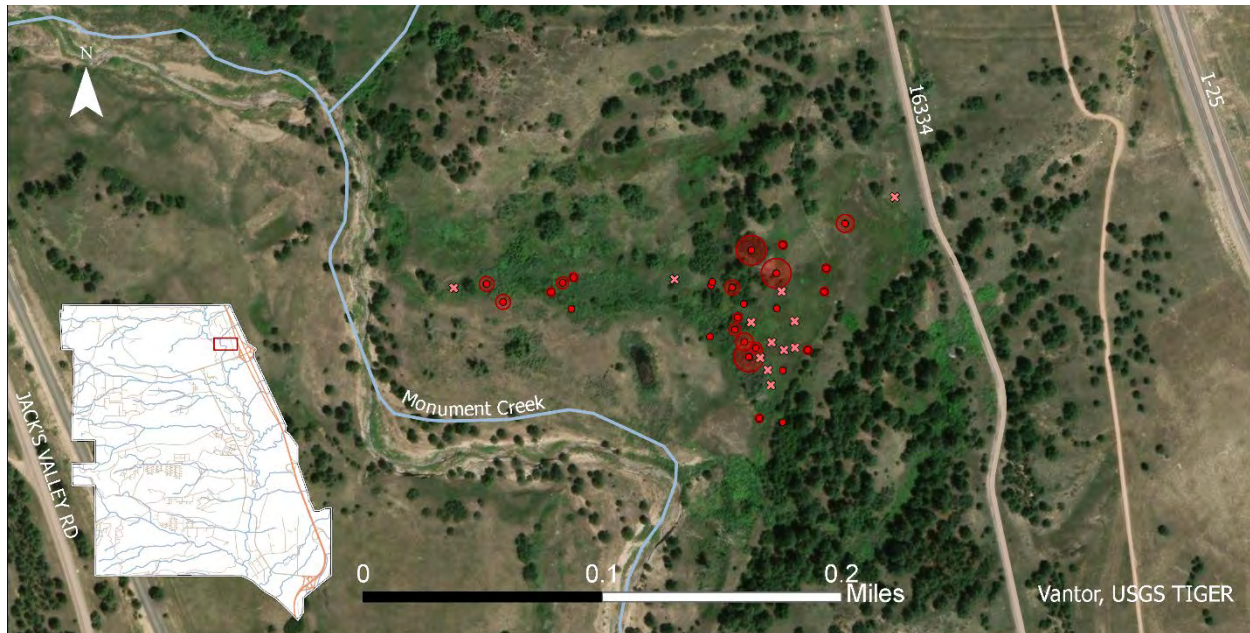


Figure 20. Houndstongue within Jack's Valley East in 2025 where the most thorough treatments were completed. There are 27 extant locations (red dots with buffered occupied zone) and 12 eradicated locations (red "x").

Recommendations

Spring precipitation is strongly correlated with increased sprouting of houndstongue (FEIS 2022a). Boom and bust cycles are typical of biennials, with large population increases following conditions that lead to larger numbers of sprouts and new plants, and large decreases or even local extinctions following situations that do not promote germination (too dry, competition, disturbance regime). Annual disturbances (too frequent), as well as absence of disturbance can be fatal for biennial plant development including houndstongue. Therefore, most habitats are usually only temporarily suitable for biennials (Zouhar, 2002b). This makes a case for leaving some populations of houndstongue without treatment, especially those with dense cover of other vegetation like the sites on the east side forested bluffs above Monument Creek (Grid G-7, Map 22) and around the wastewater treatment plant. While houndstongue may eventually work its way out of a system with healthy vegetation, in lands that are severely disturbed (e.g., topsoil and plants removed, roadsides), houndstongue has been known to persist indefinitely (Zouhar, 2002b).

Several reasons for recommending continued yearly intense manual treatments at the focus sites include the relatively short seed life (2–3) years and the short dispersal distances of seeds, which are thought to stay within five meters of the plant. Studies have shown that most seeds are not transported successfully long distances (Zouhar, 2002b). Avoid crawling into thickets to manually treat dense populations. This can cause seeds to stick to the person and transport the seeds to other sites. Thus, there is a good probability of seriously reducing or even eradicating houndstongue at Jack's Valley East and the other focused treatment areas at the Academy. Targeting the young or flowering plants is most effective with much less soil disturbance.

Recommendations for houndstongue:

- Focus monitoring and treatments at sites where eradication or control is possible.
- Treat sites by removing all parts of the plant or severing large plants at least four inches below the root crown.
- Begin monitoring/treatments at as many sites as possible in the spring to prevent plants from going to seed.
- Re-visit as many sites as possible throughout the growing season.
- Consider leaving plants in areas of dense native plants and intact habitat untreated.

All the known houndstongue sites are within the designated Special Weed Management Area (SWMA) delineated in the 2014 Weed Management Plan (Smith et al. 2015). If herbicides are utilized (which we do not recommend), follow the Guidelines for Herbicide Use in Natural Areas section of the report. Many weeds targeted for treatments are located in moist areas near wetlands and drainages, and some contain rare plant and animal species. Make sure all applicators can recognize rare plants and the rosette stage of houndstongue and are using wetland appropriate chemicals and adjuvants. For example, the basal leaves of houndstongue resemble Rocky Mountain blazing star (*Liatris ligulistylis*) and grow together at the Academy in seeps and moist areas.

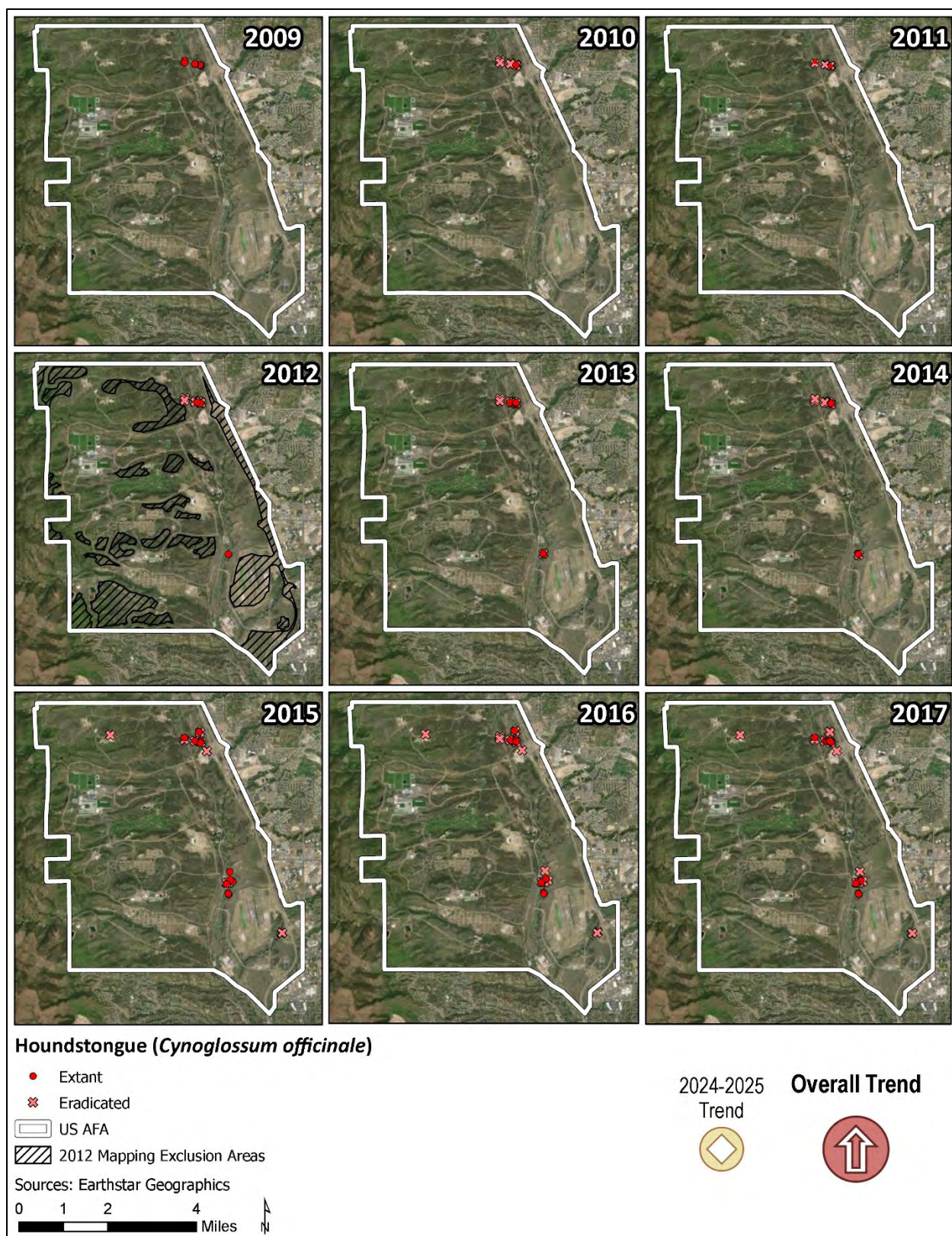
Because of the method of herbicide application (not applied to individual plants), the off-target damage from herbicides which is lethal to many other species including native plant provides fresh habitat for infestations of houndstongue and other weeds. In addition, since herbicides are not designed to be used multiple times

during the same growing season, sprouts and plants that get missed will continue to grow and set the stage for further increasing houndstongue.

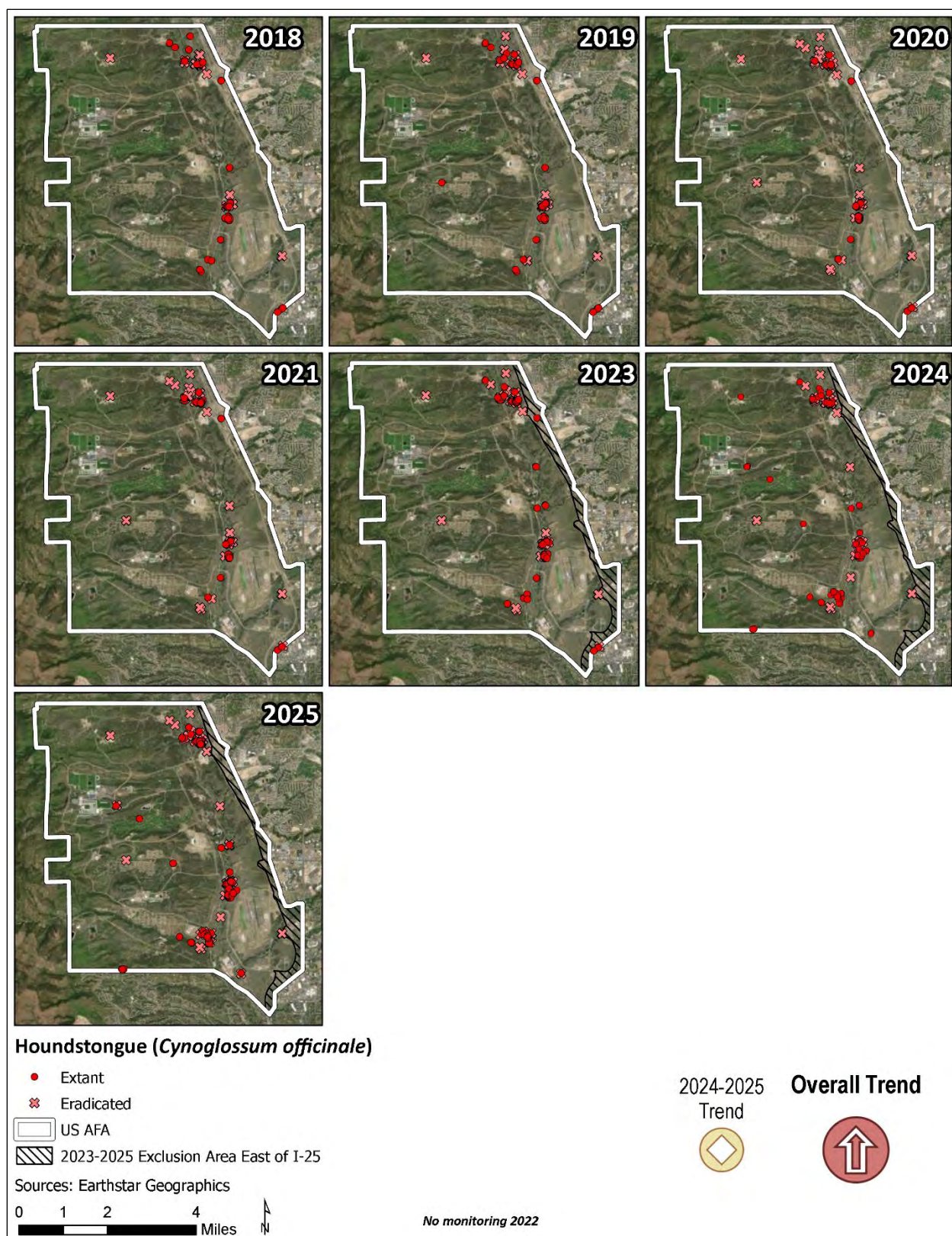
History of Sampling and Treatment

- The first populations discovered in 2009 at the Academy.
- Aggressively treated with herbicide in 2010. Populations declined but extant plants remained in 2010 and 2011.
- In 2012 a new site was located south of the existing known sites during the basewide weed survey.
- In 2013 no new sites were found, and all known sites were treated.
- In 2014 two locations that had not been mapped as part of the weed monitoring project were sprayed for houndstongue by weed contractors.
- In 2015, there was an increase in the number of sites from 16 to 33 between 2014 and 2015 with a corresponding increase in the number of individuals observed (109 to 534 individuals, respectively). Many of the new plants were new rosettes and sprouts and some of them were in previously treated areas.
- In 2016, three new points were added. There was a slight decrease in the number of individuals between 2015 and 2016 from 585 to 480, respectively.
- In 2017, there was an increase from 480 to 787 plants at a total of 26 extant features.
- In 2018, basewide mapping showed 4,514 plants in 72 extant features. Much of the increased features were along Monument Creek.
- In 2019, 3,573 shoots were mapped at 57 extant features. The majority of the plants are found at three sites: Ice Lake Road, the wastewater treatment facility and a site along Monument Creek east side.
- In 2020, houndstongue is increasing in numbers of shoots but decreasing in the number of extant sites. Nine sites contain the majority of the plants.
- In 2021, a large increase in the number of sprouting plants over the summer season compared to 2020 was noted and appears to be correlated with a significant increase precipitation in the spring and summer of 2021.
- In 2022, no surveys or treatments were undertaken.
- In 2023, 5,196 shoots were mapped and 3,865 (74%) were treated across 109 features. The number of individuals has seemingly stabilized for the time being.

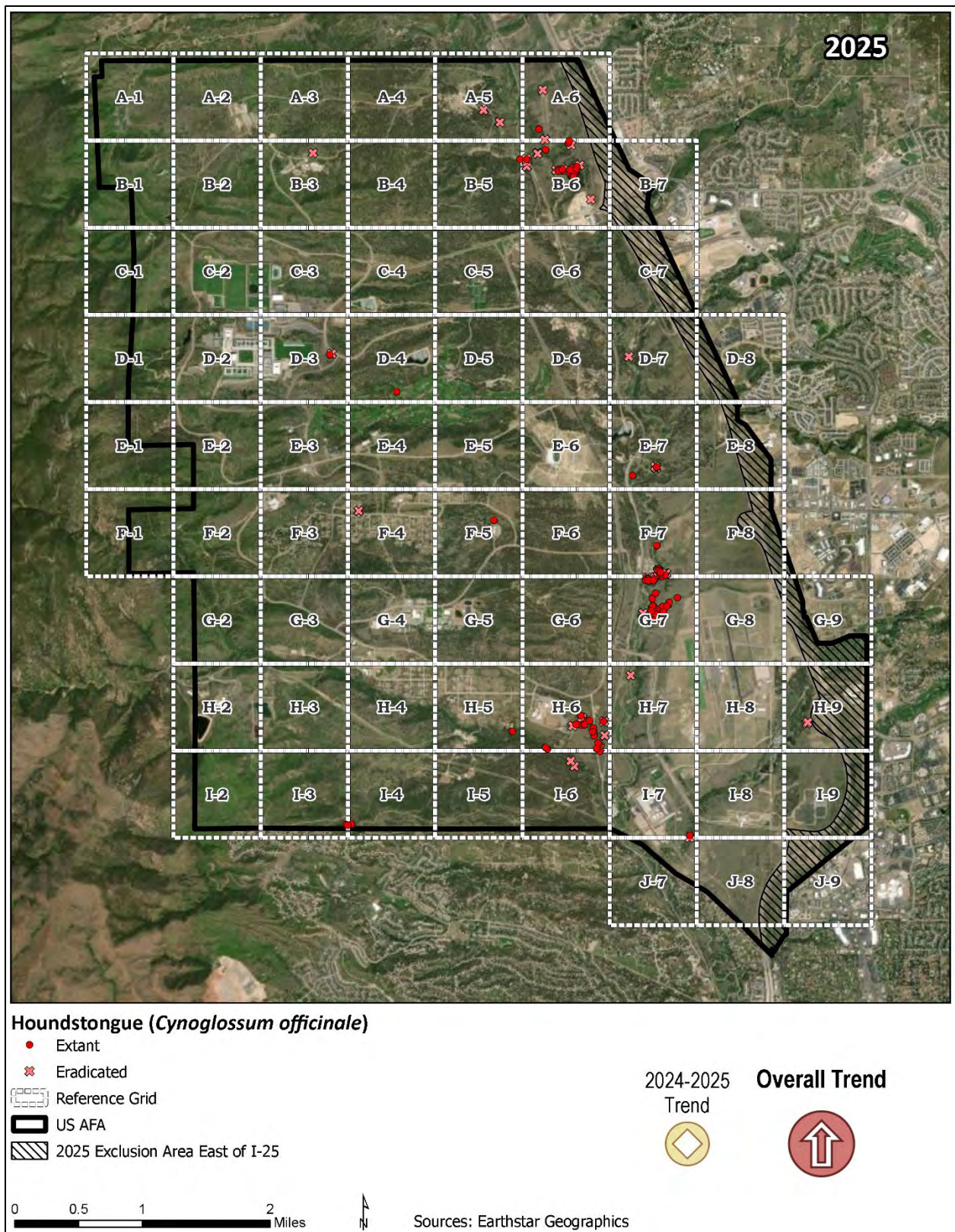
- In 2024, basewide mapping found many new populations and a substantial increase in the total number of individuals at the Air Force Academy.
- In 2025, 4,323 shoots were mapped and 2,216 (51.2%) were treated across 106 features. Efforts were focused on Jack's Valley East and other small, targeted areas where treatments appear to be successful and reducing the total population.



Map 20. Distribution of houndstongue at the Academy between 2009 and 2017.



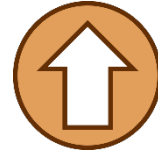
Map 21. Distribution of houndstongue at the Academy between 2018 and 2025.



Map 22. Distribution of houndstongue at the Academy in 2025 with the reference grid.

Common Teasel (*Dipsacus fullonum*)

Change from 2018–2025: Increasing
Management Goals: Suppression
State List: B



- Monocarpic perennials that will grow as rosettes for 2 or more years before flowering (Gucker, 2009).
- Can grow to six feet tall from a strong taproot (Gucker, 2009)
- Flowers July–September (Gucker, 2009)
- Reproduction only by seed, and seeds are viable for 2 years or more (Gucker, 2009)
- Three hundred seeds can be produced per head and up to 3,000 seeds per plant (Gucker, 2009)
- Seeds are spread by wind, water, animals, and by humans (Gucker, 2009)
- Teasel often grows in disturbed habitat where the canopy is open, but can be replaced by native vegetation with enough time (Gucker, 2009)



Figure 21. *Dipsacus fullonum* found in Jack's Valley (left) in 2018 – Photo by Pam Smith; The stem and leaves of *D. fullonum* (center) – Photo by Sandy Wolkenberg, CC BY 4.0; The flowers of *D. fullonum* (right) – Photo by Cbaile19, CC0, via Wikimedia Commons

2024–2025 Mapping Results

Common teasel has increased in the number of extant features, numbers of shoots, and occupied area from 2018 to 2025 (Table 24). The number of shoots has increased by 53% since 2018. This biennial species is found in moist soils mostly along Monument, Kettle, and Pine Creeks on the east side of the Academy (Map 23 and Map 24).

Table 24. All Mapping of common teasel at the Academy.

Year	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2002	18.33	1,693	35	---
2007	10.51	53,454	181	---
2012¹	9.26	116,595	319	65
2018	11.27	123,921	364	185
2024²	11.89	188,990	398	229
2025³	11.87	189,750	397	231

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Noxious weeds were not mapped basewide and were instead only mapped within designated mapping areas in 2012 (see Figure 3 for designated mapped areas).

² Noxious weeds were not mapped east of I-25 in 2024 due to ongoing construction. 15 teasel features which are east of I-25 were excluded from the 2024 mapping and analysis.

³ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

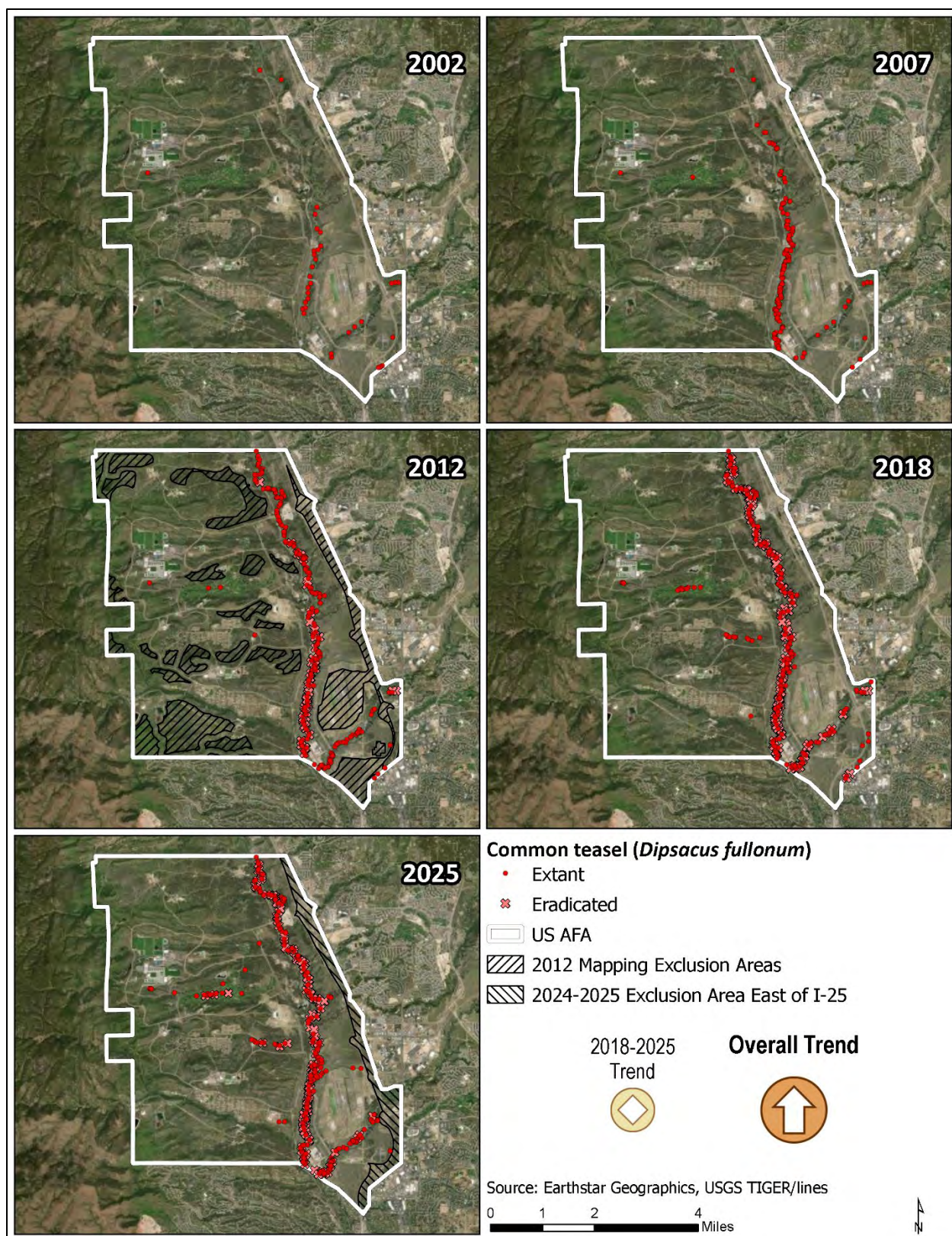
Common teasel has dense cover in patches along drainages at the Academy. Biennials tend to phase out of natural areas as long as the soil is not continually disturbed. Some locations near drainages are subjected to frequent flooding and disturbances. Flooding events, pulling, and herbicide treatments that impact soils will keep the area in an early seral stage that favors the establishment of weeds like common teasel. Published studies indicate that treated teasel patches tend to be much less biodiverse than they were pre-treatment. The presence of teasel does not necessarily mean impacts to native species. However, the impacts of removing the teasel, especially since the current cover is high, could be more disturbing to the surrounding vegetation than leaving the teasel in place. The moisture gradient is particularly important in determining the extent to which this plant will be able to move into an adjacent area and should be considered in a site plan before treatments occur.

Recommendations

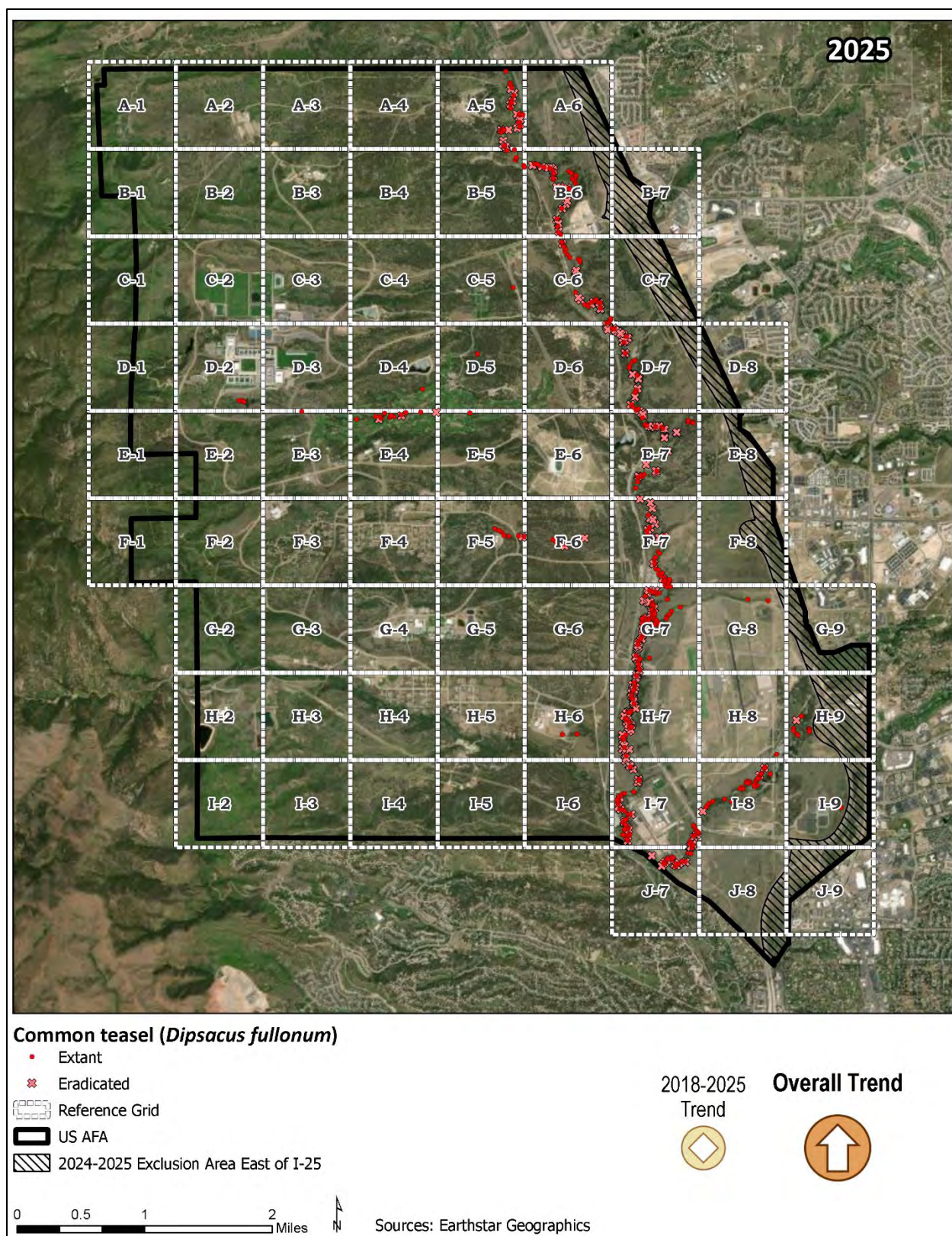
The Colorado Department of Agriculture recommendations for treating teasel infestations indicate that mechanical methods are best for infestations smaller than one-half acre. Depending on the density, replanting with native species may be necessary. Any treatment should consider not harming other native plants present, ecology, and site condition. Sever roots below the soil surface during the first year before the plant stores energy (rosette stage) and in the second year before seed production. Flower heads must be collected, bagged, and disposed of or destroyed; seeds will mature and germinate if left on the ground. All chemicals recommended are for pastures and rangelands, none are recommended for wildlands. Treatments should start at the perimeter. Follow-up monitoring should occur within a couple of months of initial treatments. A site plan with specific tasks for what the treatment will entail and the expected outcomes and monitoring timelines should be in place before moving forward with treatments.

History of Sampling and Treatment

- Common teasel was mapped as part of the basewide surveys in 2002, 2007, 2012, 2018, and 2024.
- In 2025, supplementary basewide mapping was performed to capture select areas that were not mapped in the 2024 basewide survey.



Map 23. Distribution of common teasel at the Academy from base-wide weed surveys (2002, 2007, 2012, 2018, and 2024-2025).



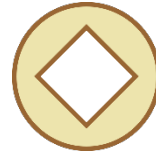
Map 24. Distribution of common teasel at the Academy from basewide weed survey in 2024-2025.

Russian olive (*Elaeagnus angustifolia*)

Change from 2018–2025: Stable

Management Goals: Containment

State List: B



- Multi-stemmed shrub/tree (40ft) (Colorado Department of Agriculture [CDA], 2015b)
- Deep and extensive root system (Zouhar, 2005)
- Reproduction by seed and post injury sprouting, suckers (CDA, 2015b)
- Seeds viable for 3 years (CDA, 2015b; Zouhar, 2005)
- Seeds are spread by birds and other animals (CDA, 2015b; Zouhar, 2005)
- Cultivated plant that which has escaped cultivation (Zouhar, 2005).
- Can establish at non-disturbed or disturbed sites (Zouhar, 2005)



Figure 22. *Elaeagnus angustifolia* foliage (left) and immature fruit (right) – Photos by Robert Monahan, 2024

2024–2025 Mapping Results

The basewide survey data indicate the numbers of shoots and extant features are stable at the Academy within the comparable mapping area (Table 25, Table 26, Map 25, and Map 26). The comparable mapping area excludes Russian olive features at the base east of I-25, which was not mapped in 2024 or 2025, and features that fall in the 2012 mapping exclusion areas. Within the comparable area (Table 26) there was a slight increase in the number of shoots and a decrease in the number of extant features.

Table 25. All Mapping of Russian olive at the Academy.

Year	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2002¹	49.79	1,310	269	---
2007	19.08	633	114	156
2012²	16.27	689	193	200
2018	6.91	653	108	322
2025³	6.22	669	101	335

¹ 2002 values are sums of 2002 and 2003 mapping.

² Noxious weeds were not mapped basewide and were instead only mapped within designated mapping areas in 2012 (see Figure 3 for designated mapped areas).

³ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

Table 26. Russian olive within comparable mapping areas at the Academy.

Year	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2002¹	26.65	889	191	---
2007	4.23	342	61	129
2012	3.29	384	122	169
2018	2.03	493	69	251
2025	3.89	506	59	263

¹ 2002 values are sums of 2002 and 2003 mapping.

Recommendations

Management urgency for Russian olive is considered to be low due to low cover and consistent decrease in the number of trees.

Recommendations for Russian olive:

- Continue to map new locations every five years to monitor if there is a large increase in the number of individuals.
- Double check the species identification at every site before treatment as Silver buffaloberry (*Shepherdia argentea*) (Figure 23) can be deceptively similar in appearance without careful inspection. Stretchberry (*Forestiera pubescens*) (Figure 24) can also be easily mistaken for Russian olive.

Cut-stump with herbicide treatment is recommend for Russian olive (CDA, 2015b). For this method to be effective, plants are cut close to the ground (12-15 inches above ground) in summer to fall. Herbicide should be immediately and carefully applied to the cut to increase the amount of herbicide translocated into the stump. The two recommended herbicides are triclopyr and glyphosate (CDA, 2015b).



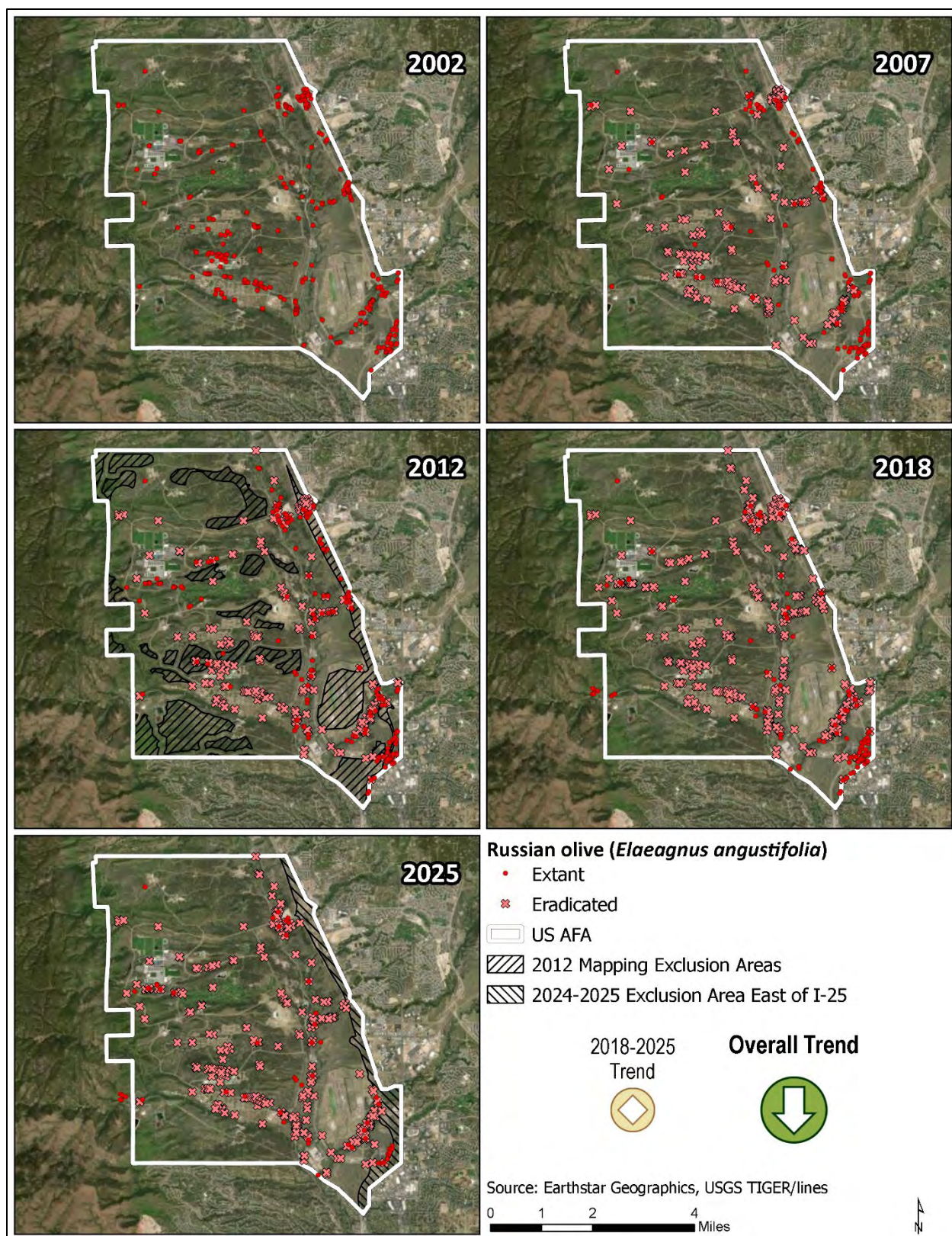
Figure 23. Silver buffaloberry (*Shepherdia argentea*), leaves (left), thorns (center), and ripe berries (right) – Photos by Robert Monahan, 2024.



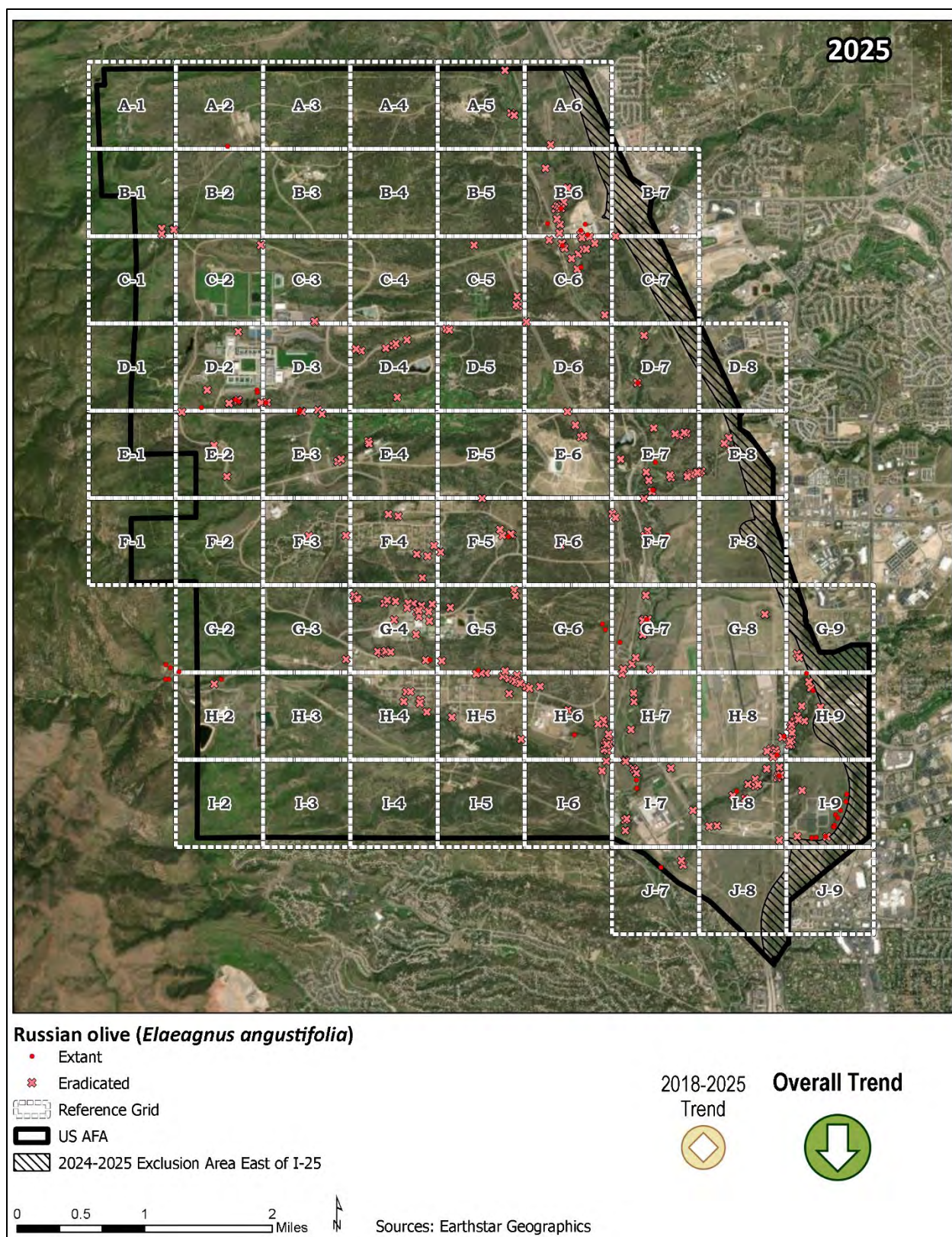
Figure 24. Stretchberry (*Forestiera pubescens*) at Kettle Creek

History of Sampling and Treatment

- Russian olive was mapped as part of the basewide surveys in 2002, 2007, 2012, 2018, and 2024.
- Extreme drought in 2002 followed by relatively average precipitation in 2003 necessitated a second year of mapping in 2003.
- In 2025, supplementary basewide mapping was performed to capture select areas that were not mapped in the 2024 basewide survey.



Map 25. Distribution of Russian olive at the Academy from basewide weed surveys (2002, 2007, 2012, 2018 and 2024-2025).



Map 26. Distribution of Russian olive at the Academy from basewide weed survey in 2024-2025.

Myrtle Spurge (*Euphorbia myrsinites*)

Change from 2024–2025: Increasing rapidly

Management Goals: Eradication – Rapid Response

State List: A



- Evergreen perennial
- Reproduces by seed and can reproduce from root fragments (Stevens & Young, 2022).
- Seeds projected fifteen feet from plant by seed pods (Stevens & Young, 2022).
- Milky sap is an irritant to the skin (Stevens & Young, 2022).
- Planted in gardens and readily escapes (Stevens & Young, 2022).
- Possibly spread by birds to the Academy.
- Seed longevity 8 years



Figure 25. *Euphorbia myrsinites* found at the Air Force Academy in 2024 – Photos by Robert Monahan

2025 Mapping Results

Myrtle spurge increased from just 35 plants in the first pass of 2024, to 247 plants found in the first pass of 2025. There were 71 sites visited, 12 of those were extant (Table 27). High precipitation in 2025 is likely one factor that contributed to a higher number of individuals this year. Additionally, Gambel oak treatments at the southern end of the base (I-5, Map 29) likely contributed to a rapid increase of myrtle spurge near one previously eradicated site. Opening the canopy combined with the soil disturbance may have created conditions ideal for dormant seeds to sprout. Myrtle spurge is found throughout the Academy (Map 27, Map 28, and Map 29).

Although there was a large increase in the number of individuals mapped and treated in 2025 compared to 2024 (Table 1), the overall trend for this species is show a decline (Table 6).

Table 27. Mapping of myrtle spurge at the Academy during the first pass.

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002	---	---	---	---
2005	?	25	7	0
2006	?	243	10	0
2007	0.18	1,021	7	6
2008	0.66	419	13	5
2009	2.4	464	12	6
2010	0.5	56	10	12
2011	0.25	57	12	16
2012¹	0.23	113	10	25
2013	?	129	19	12
2014	0.7	179	7	27
2015	1.04	173	14	26
2016	0.70	185	17	26
2017	1.15	501	25	23
2018	0.51	222	26	35
2019	0.97	375	34	29
2020	0.41	63	16	47
2021	0.86	103	19	43
2022	---	---	---	---
2023	0.53	166	17	47
2024²	0.21	35	6	62
2025³	0.25	247	12	59

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Noxious weeds were not mapped basewide and were instead only mapped within designated mapping areas in 2012 (see Figure 3 for designated mapped areas).

² One previously extant (2019–2021) myrtle spurge feature east of I–25 was excluded from the 2024 mapping and analysis. This feature was not monitored from 2022 to 2024.

³ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

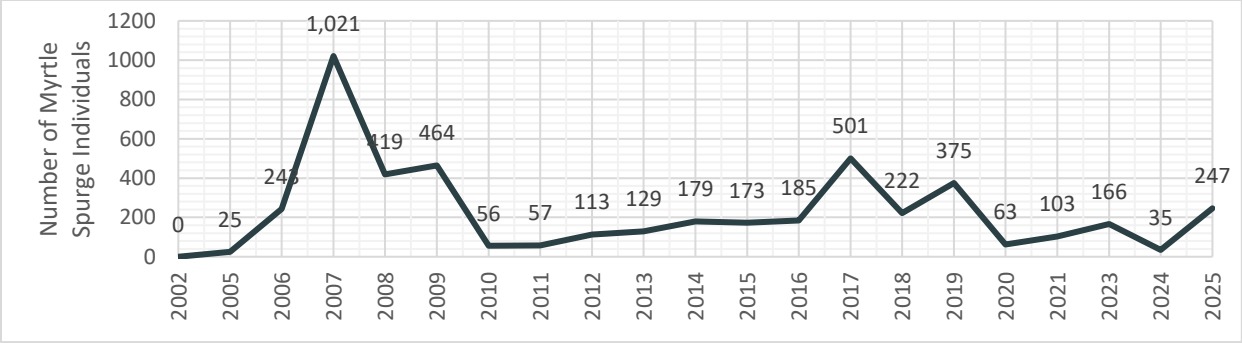


Figure 26. Number of myrtle spurge individuals mapped during the first pass from 2005 to 2025.

2025 Treatment

In 2025, a total of 136 visits were made to 71 sites and 257 individuals were removed (Table 28). No myrtle spurge plants at the mapped sites are known to have gone to seed in 2025.

Table 28. Monitoring and treatment of myrtle spurge sites at the Academy in 2025.

Pass & Year	# Site Visits	# Shoots Mapped	# Manually Treated Shoots	# Sites with Plants	# Sites without Plants
2025 Pass 1	71	248	248	13	58
2025 Pass 2	64	9	9	5	59
2025 Pass 3	1	0	0	0	1
2025 Total	136	257	257	---	---
2019	93	432	432	---	---
2020	78	132	132	---	---
2021	159	1,355	1,355	---	---
2022	---	---	---	---	---
2023	137	227	227	---	---
2024*	147	68	68	---	---
2025	136	257	257	---	---

* One previously extant (2019–2021) myrtle spurge feature east of I-25 was excluded from the 2024 mapping and analysis. This feature was not monitored from 2022 to 2025.

Recommendations

Myrtle spurge is a high management priority at the Academy as a List A species. It is a perennial species that reproduces by seed. At the Academy there is a high probability of control or eradication so long as aggressive treatments continue. Treatment efforts have shown promising results. There has been a continual reduction in the number of individuals at most sites year after year and some sites remaining eradicated for many years. Myrtle spurge plants are found throughout the

base covering a quarter acre in 2025. Cover of more than an acre for many species is often a level where eradication is difficult. In addition, the plants are widely distributed across the Academy and the seed longevity is thought to be eight years.

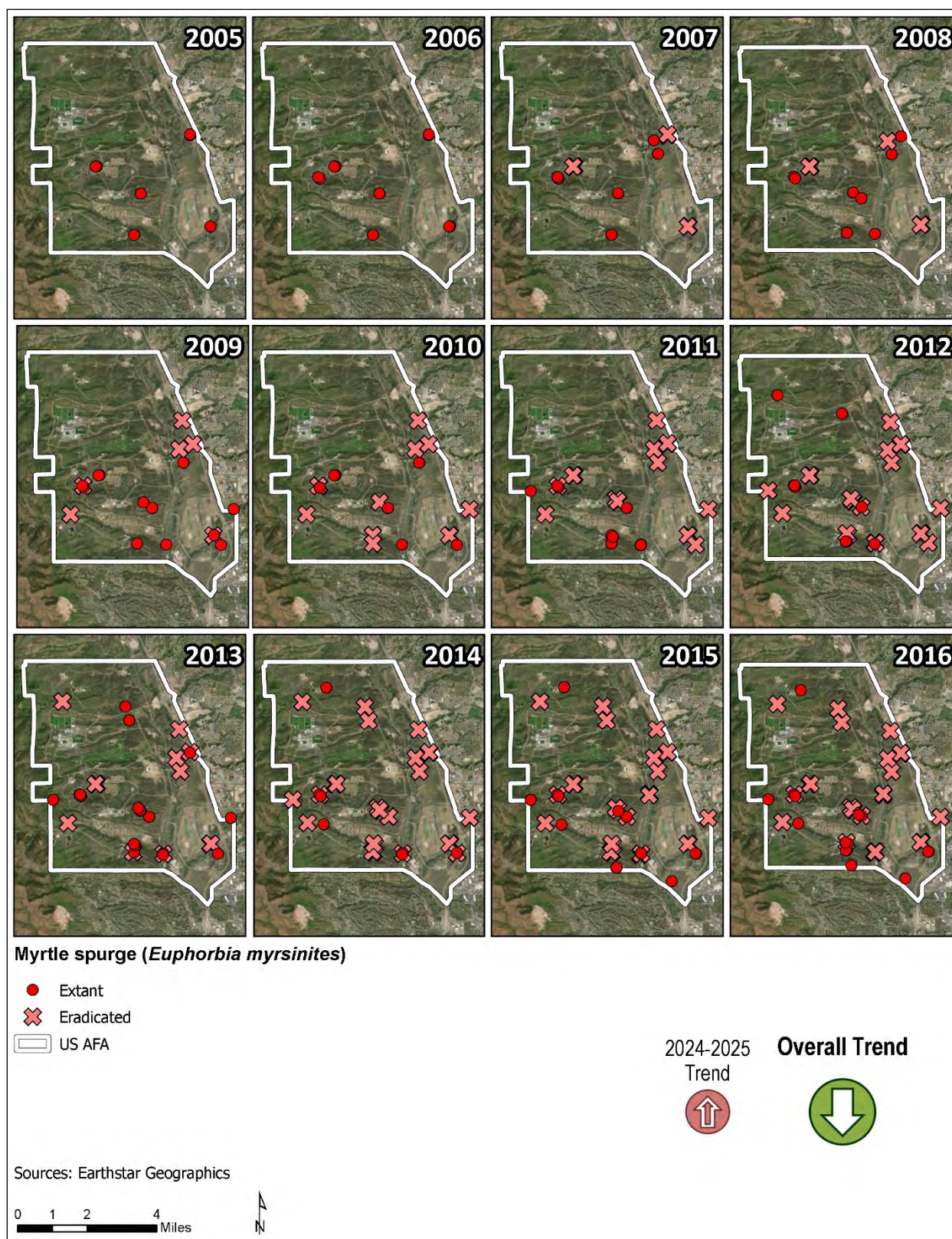
Recommendations for myrtle spurge:

- Continue to monitor all known myrtle spurge sites in the spring (myrtle spurge blooms as early as March).
- Continue to remove all plants and prevent them from going to flower/seed.
- Continue to re-visit as many sites as possible to treat sprouts two or three times during the growing season.
- Continue to re-visit long eradicated sites. Old seeds may sprout with the correct environmental conditions, and it will be important to remove any sprouts before seeds are produced.

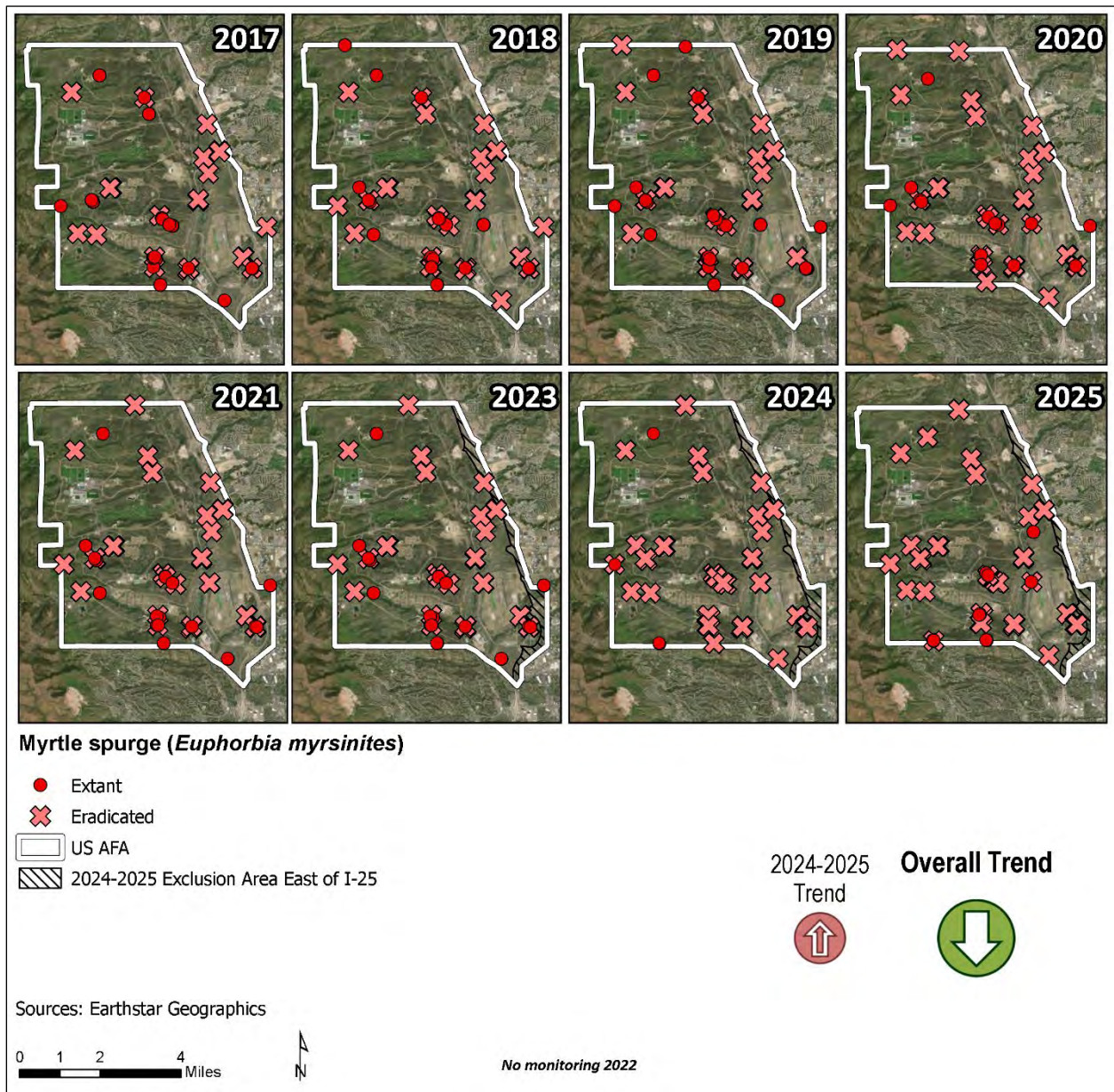
History of Sampling and Treatment:

- Natural Resources Staff at the Academy identified the presence of myrtle spurge in 2005 at an early stage of its invasion with seven sites and 25 individuals.
- In 2007, the highest number of plants (1,021) was documented for myrtle spurge.
- 2008–2016 yearly increases in the number of individuals.
- In 2016, 185 individuals were observed at 17 extant features.
- In 2017, we saw an increase in plants at or near known sites from 185 individuals in 2016 to 501 in 2017.
- In 2018, a basewide mapping effort showed myrtle spurge has spread across the entire property and continues to be found even in treated areas.
- In 2019, sprouts were pulled in the spring and throughout the summer. No seeds were produced at the known sites in 2019.
- In 2020, there was a reduction in the number of sites and number of individuals compared to 2019. Sprouts were pulled early in the spring and throughout the summer which resulted in no seed production at the sites.
- In 2021, the number of extant sites remained stable while the number of individuals jumped mid-summer due to a sprouting event at a single site likely due to higher precipitation amounts.
- In 2022, no surveys or treatments were undertaken.

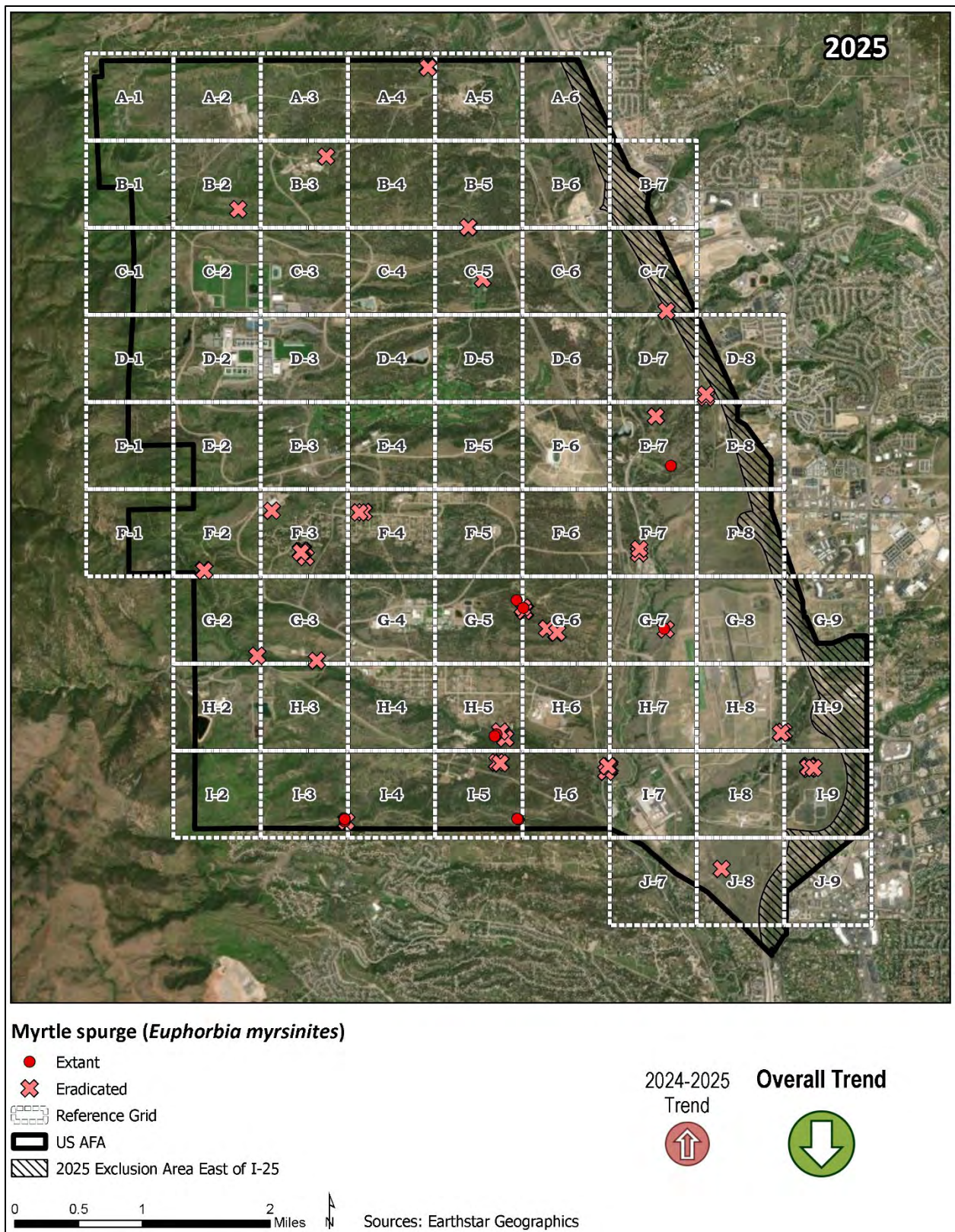
- In 2023, the number of sites remained stable to slightly decreasing number of individuals. No large sprouting event occurred this year, but it will be important to continue monitoring to avoid these large events.
- In 2024, the basewide mapping effort resulted in the discovery of a new population near the southern edge of the base. This population composed of four sites and sixty individuals, was treated before any individuals flowered. Many known sites were eradicated for the second year in row or had very few individuals.
- In 2025, all known locations were visited and treated before any plants were able to go to seed. Many sites have remained eradicated for three years, but presence of new sprouts at couple previous eradicated sites indicate the importance of monitoring sites years after their initial eradication.



Map 27. Distribution of myrtle spurge at the Academy between 2005 and 2016.



Map 28. Distribution of myrtle spurge at the Academy between 2017 and 2025.



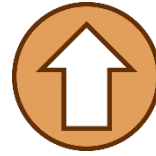
Map 29. Distribution of myrtle spurge at the Academy in 2025 with the reference grid.

Leafy Spurge (*Euphorbia virgata*)

Change from 2018–2025: Increasing

Management Goals: Containment

State List: B (Listed as *Euphorbia esula*)



- Perennial with extensive root system that can reach fifteen feet in depth (Gucker, 2011).
- Reproduction from seed and root buds, seeds ejected fifteen feet from the parent plant (Gucker, 2011).
- Plant has white milky sap (Gucker, 2011).
- Seed longevity 5 or more years (Gucker, 2011).
- Survives in a wide range of habitat types (Gucker, 2011).
- Leafy spurge in the Americas was misidentified as *Euphorbia esula* for many years but later discovered to in fact be *Euphorbia virgata*, a closely related species. (Ackerfield, 2022; Riina et al., 2020)



Figure 27. *Euphorbia virgata* flowers (left) – Photo by HermannSchachner, CC0; *Euphorbia virgata* at the Academy in August 2024 (right) – Photo by Robert Monahan

2024–2025 Mapping Results

The mapping results show an overall increasing trend for leafy spurge at the Academy since 2002 for occupied acres, estimated number of shoots and number of extant features. However, since 2007, the numbers of shoots have decreased but are still higher than in 2018 (Table 29, Map 30, and Map 31).

Table 29. Mapping of leafy spurge at the Academy.

Year	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2002	1.09	35,387	38	---
2007	8.21	372,666	162	2
2012 ¹	11.97	327,018	215	30
2018	11.77	230,883	224	80
2024 ²	13.92	265,907	239	84
2025 ³	13.97	266,574	240	84

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Noxious weeds were not mapped basewide and were instead only mapped within designated mapping areas in 2012 (see Figure 3 for designated mapped areas).

² Noxious weeds were not mapped east of I-25 in 2024 due to ongoing construction. 4 leafy spurge features which are east of I-25 were excluded from the 2024 mapping and analysis.

³ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

Recommendations

- 1) Consider monitoring for other leafy spurge locations for the presence of biocontrol agents. For populations which appear to be declining naturally, monitoring is recommended to prevent disturbance.
- 2) Herbicide application is not recommended for leafy spurge populations without site plans, as the biocontrol organisms (flea beetles from the genus *Aphthona*) may be present. Monitoring data shows the biocontrol organisms are working as the six-year monitoring trend is showing stable to decreasing trends. Evidence of biocontrol was noted in 2016, 2017, and 2018. No biocontrol agents were observed in 2024 or 2025, although they may still be present. These organisms may contribute decreases in population or help to stabilize the increasing trend if they are still present.

A study in Rocky Mountain National Park demonstrated that leafy spurge management practices including both chemical and mechanical treatments resulted in impacts to soils, soil biota and native plant species that were as damaging as the impacts from the leafy spurge itself (Pritekel et al. 2006). This calls into question the efficacy of treating these plants in systems where you need to protect native vegetation.

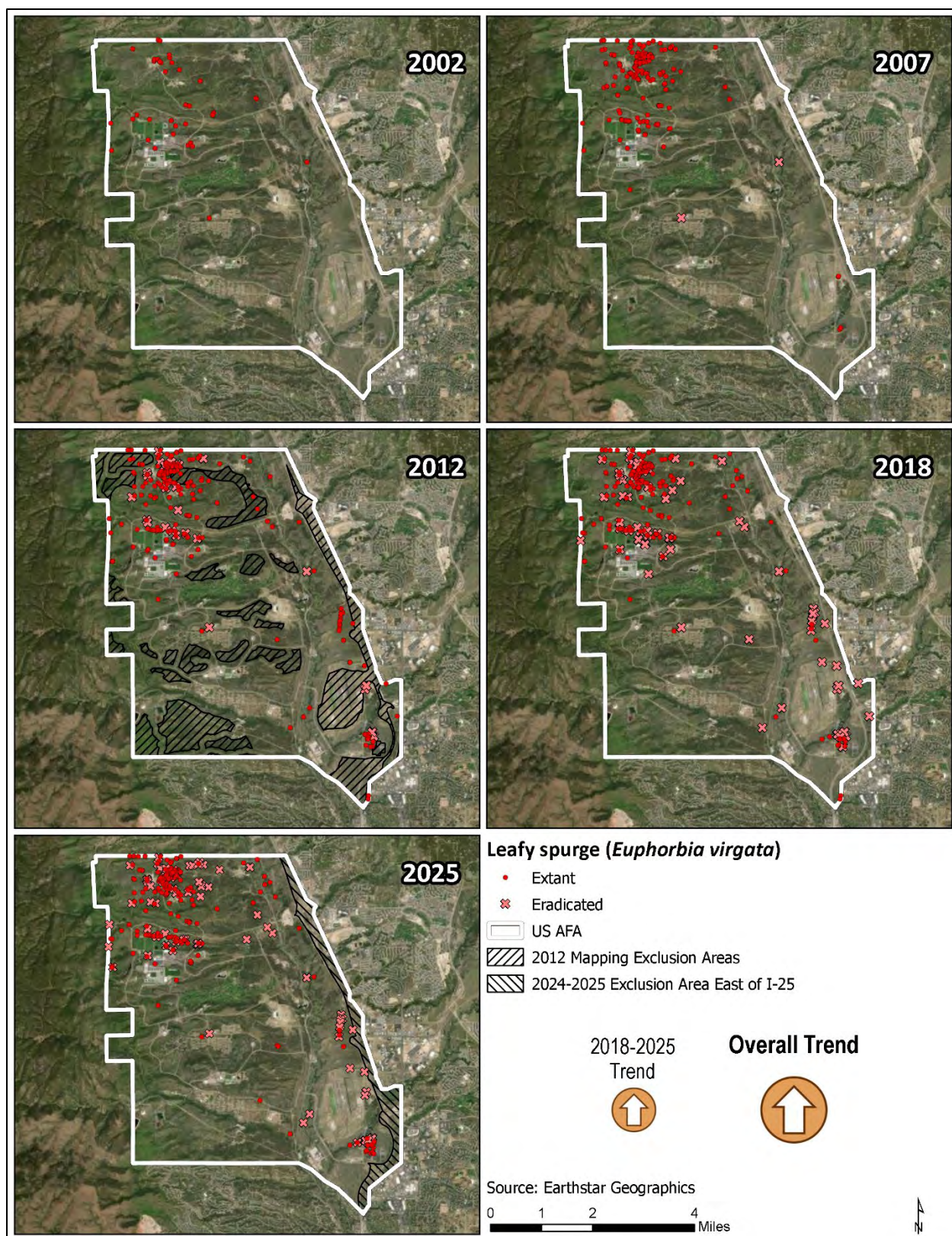
A greenhouse study conducted in 2008 (Nicholas et al.) showed that leafy spurge seedling growth was lower in spots that had native species compared to soils that had smooth brome. This further brings home the point that disturbance of the soils will encourage the growth of leafy spurge or other non-native species. Protecting areas with native plant cover from disturbance (including herbicides) should be a priority to protect soil chemistry and to prevent leaving bare spots where smooth brome often moves in.

Protocols for treating weeds in the vicinity of rare plants has been developed by the State of Colorado (Mui and Panjabi, 2016), and should be considered for management activities in the areas designated by Smith et al. (2015) as SWMAs.

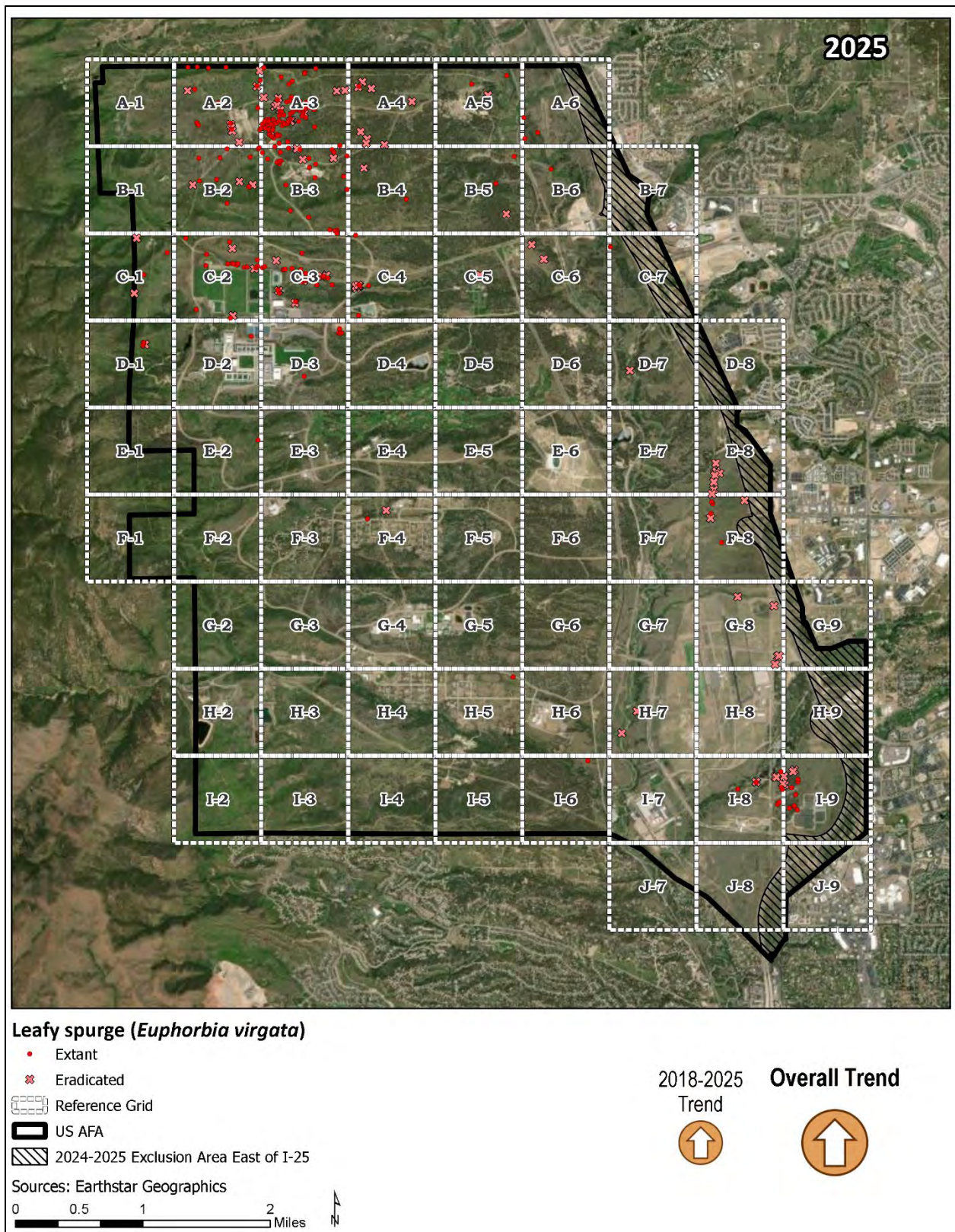
History of Sampling and Treatment

- Ten permanent plots were established in 2012.
- Census mapping for leafy spurge distribution across the Academy property was conducted in 2002, 2007, and 2012.
- Michaels et al. terminated biocontrol treatments in 2013.
- In 2013, a need was recognized for more accurate treatment application data that includes area treated, date, and type of treatment.
- In 2015, all non-biocontrol treatment plots were visited. Rare plants (*Phacelia denticulata*) were noted in EUES 10.
- In 2016, all ten plots were visited. There was a decrease in the percent cover of leafy spurge while the frequency and density were stable 2012–2016. No plots were treated with herbicide. Rare plants (*Phacelia denticulata*) were again noted in plot EUES 10. Evidence of biocontrol organisms causing impacts to flowering plants was noted in six plots at a total of eleven quadrats.
- In 2017, all ten plots were visited. Gambel's oaks are continuing to encroach on the plots. Leafy spurge seems to be declining without treatments. Another rare plant species was located in EUES 4 & 5 (*Crocianthemum bicknellii*). Evidence of biocontrol is common and found in the majority of plots over multiple years, animal browse has also been frequently observed.

- In 2017, no leafy spurge was mapped at Farish.
- In 2018, basewide mapping at the Academy showed an overall increase from 2002. Ten plots were monitored in 2018 showing stable to declining populations of leafy spurge and active biocontrol.
- In 2024, basewide mapping at the Academy showed a moderate increase in all metrics, and no biocontrol agents were observed during mapping.
- In 2025, supplementary basewide mapping was performed to capture select areas that were not mapped in the 2024 basewide survey.



Map 30. Distribution of leafy spurge at the Academy from basewide weed surveys (2002, 2007, 2012, 2018 and 2024-2025).



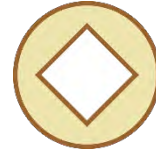
Map 31. Distribution of leafy spurge at the Academy from basewide weed surveys in 2024-2025.

Yellow Spring Bedstraw (*Galium verum*)

Change from 2024–2025: Stable

Management Goals: Containment – Rapid Response

State List: Not Listed in Colorado (Garden Escape)



- Perennial forb (can be vine-like)
- Has the potential to be invasive once it becomes established.
- Spreads by seeds and rhizomes (Plue et al., 2022)
- Produces 45–155 seeds per m² of *Galium verum* (Plue et al., 2022)
- Blooms June–September
- Dry disturbed sites
- Escaped ornamental.
- Seeds are short-term persistent with a Seed Longevity Index of 0.048 which translates to less than 1 year (Plue et al., 2022)



Figure 28. A dense patch of *Galium verum* at Air Force Academy 2024 (left) – Photo by Robert Monahan; *Galium verum* view of the stem up close, displaying the whirled leaves and flower buds (right) – Photo by W. Bulach, CC BY-SA 4.0, via Wikimedia Commons

2024–2025 Mapping Results

There was a large increase in yellow spring bedstraw since 2023 from just 6,136 plants to an estimated 189,607 shoots mapped in 2024. Very few locations of yellow spring bedstraw were mapped in 2025 in order to prioritize other species. Yellow spring bedstraw is a garden escape that was first documented in 2010 and has been mapped at the Academy since then. (Table 30, Figure 29, Map 32, and Map 33).

Table 30. Mapping of yellow spring bedstraw at the Academy during the first pass.

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002	---	---	---	---
2007	---	---	---	---
2010	<0.01	700	1	0
2011	<0.01	1	1	0
2012 ¹	0	0	0	1
2013	0	0	0	1
2014	0	0	0	1
2015	<0.01	10	1	0
2016	0	0	0	1
2017	0	0	0	1
2018	<0.01	102	1	0
2019	0	0	0	1
2020	0.08	940	2	0
2021	0.08	210	3	0
2022	---	---	---	---
2023	0.337	6,136	3	2
2024	0.52	189,410	12	1
2025 ²	0.52	189,607	11	2

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Noxious weeds were not mapped basewide and were instead only mapped within designated mapping areas in 2012 (see Figure 3 for designated mapped areas).

² Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

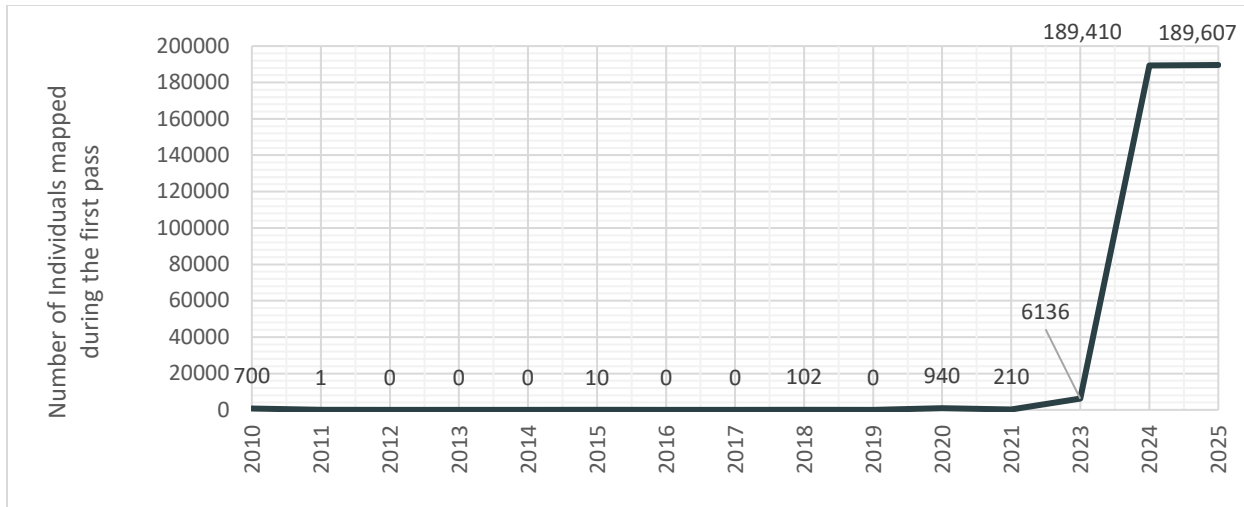


Figure 29. Number of yellow spring bedstraw individuals mapped during the first pass, 2010-2025.

2025 Treatment

In 2025, just two yellow spring bedstraw sites were visited, which are known to have a small number of individuals (Table 31). Sites where bedstraw is known to occur in large quantities have been deprioritized in 2025 because manual treatments are unlikely to have any impact on those populations. The sites with a large number of individuals have understories which are dominated by yellow spring bedstraw with little or no other plant diversity. One site is frequented by students from the high school, as evidenced by well-worn trails leading to the school and makeshift seating. Students may unintentionally be contributing to the spread of bedstraw to new locations.

Table 31. Monitoring and treatment of yellow spring bedstraw sites at the Academy in 2025.

Pass & Year	# Site Visits	# Shoots Mapped	# Manually Treated Shoots	# Sites with Plants	# Sites without Plants
2025 Pass 1	2	30	30	1	1
2025 Pass 2	1	13	13	1	0
2025 Total	3	43	43	---	---
2019	1	0	0	---	---
2020	4	1,049	749	---	---
2021	4	327	327	---	---
2022	---	---	---	---	---
2023	9	7,317	1,317	---	---
2024	13	189,410	1,759	---	---
2025	3	43	43	---	---

Recommendations

Yellow spring bedstraw is a high management priority as its relative cover has been increasing rapidly and is currently only found in the West Monument Creek area. Eradication seems increasingly unlikely for this species; therefore, it is recommended that the species be contained to the West Monument Creek area and prevent its spread onto the upland or Monument Creek. Seeds are short-term persistent (Plue et al. 2022). Although this plant is not on the State of Colorado noxious weed list, it is an escaped ornamental plant that has been shown to be aggressive at the Air Force Academy and throughout southern Canada and the northern U.S. It is a rhizomatous perennial plant that does well in dry soils and is able to effectively outcompete other understory species. It is found on the edge of disturbed riparian areas with many native shrubs and herbs at the Academy.

A 2017 study by Heckmen et al. looked at the effects of treating yellow spring bedstraw with hand pulling and selective herbicide (2, 4-dichlorophenoxyacetic acid) in a tallgrass prairie ecosystem in Virginia. Results from the study show that hand pulling, and herbicides can effectively reduce bedstraw density without reducing grass diversity, but only hand pulling treatments had an increase in forb diversity (Heckmen et al. 2017). This indicates that hand pulling treatments should continue to be used for small populations where native vegetation is intermixed with bedstraw. However, in larger populations, especially those away from water ways and where forb diversity is low, selective herbicides should be considered as a potential alternative treatment.

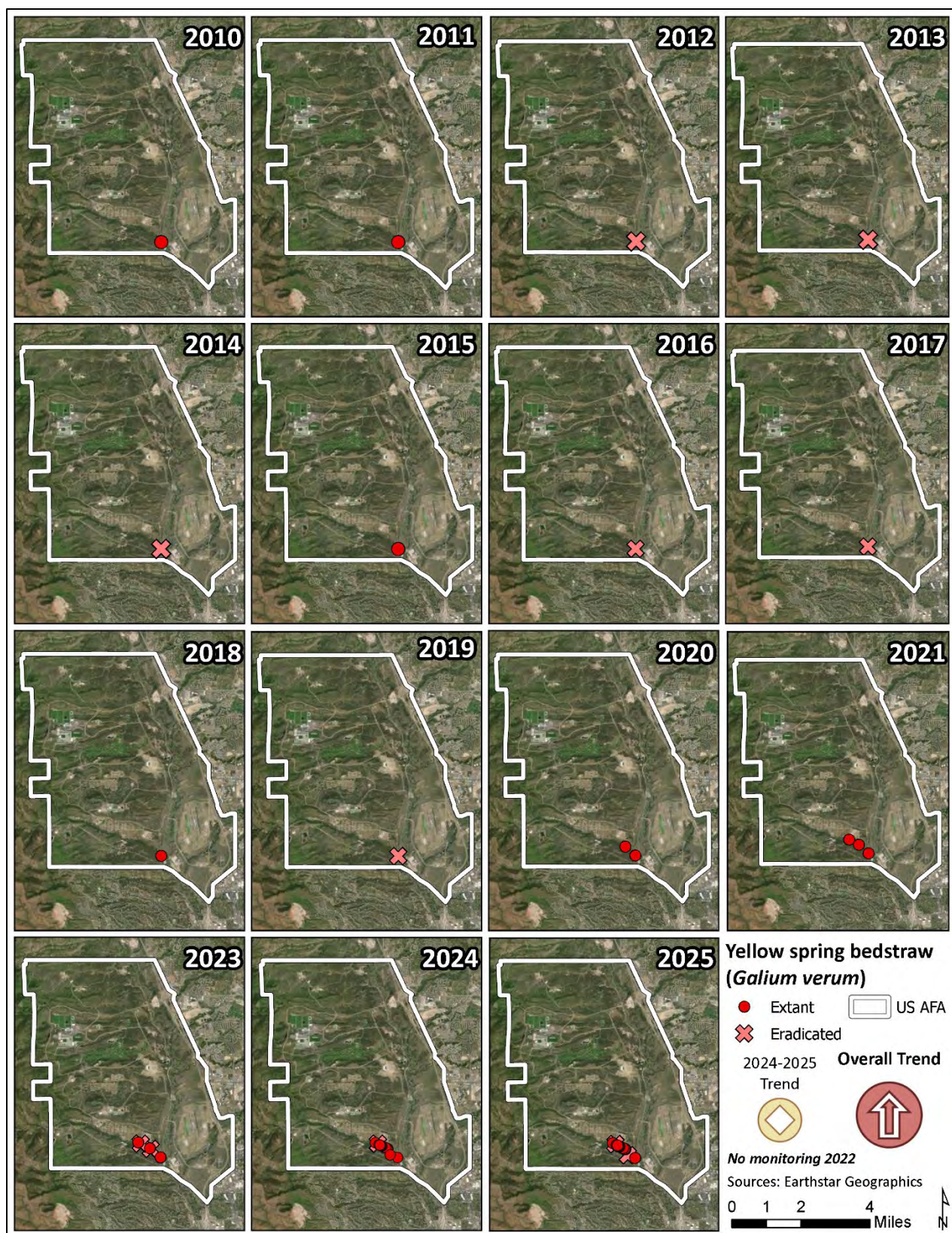
Recommendations for yellow spring bedstraw:

- Continue to monitor the known locations.
- Remove plants when populations are small, with as little soil disturbance as possible.
- Revisit sites throughout the summer.
- Look for potential seed sources in residential areas.
- Consider the use of herbicides in areas dominated by bedstraw, which are away from waterways and have low forb diversity.

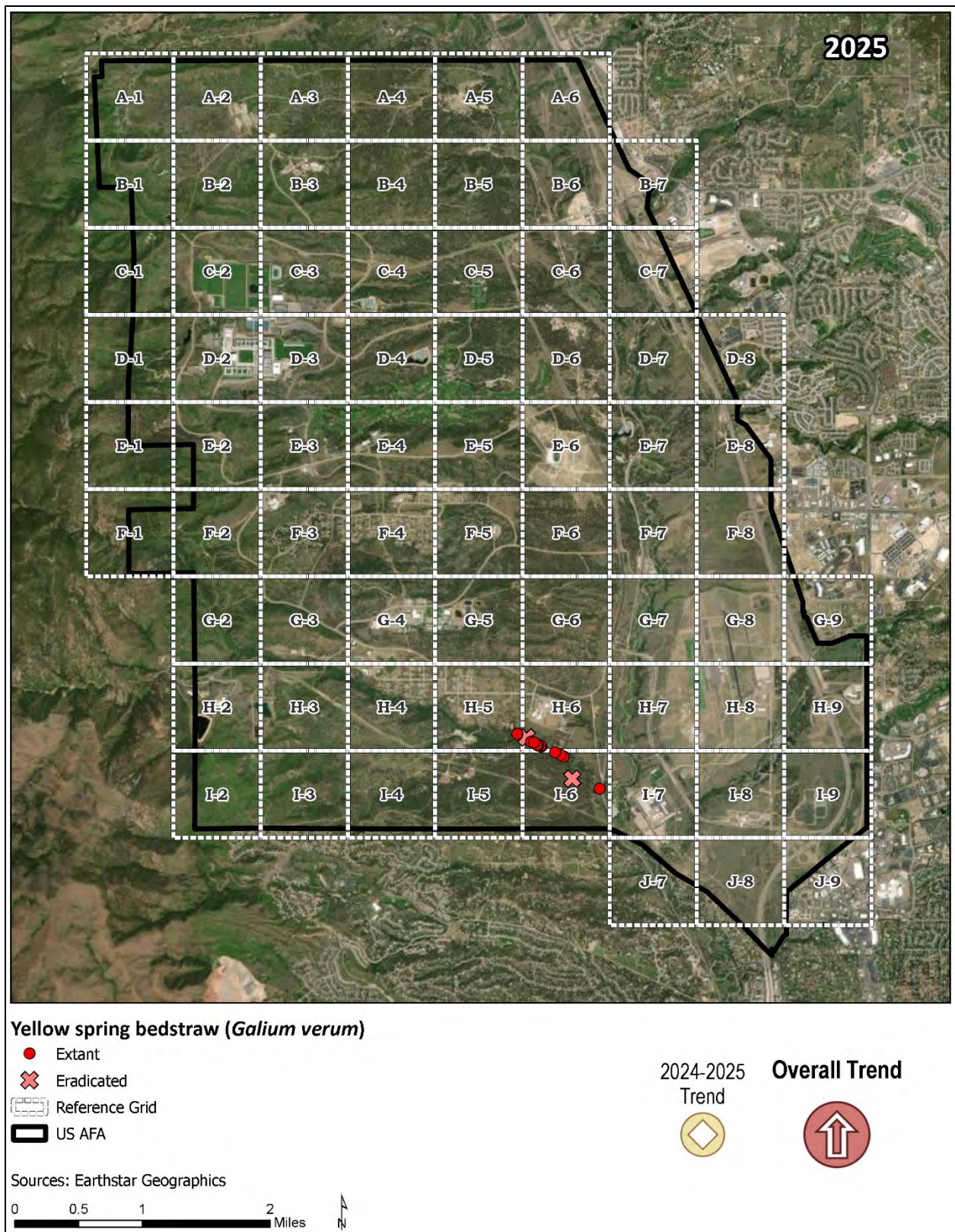
History of Sampling and Treatment:

- This species was discovered at the Academy in 2010 with one occurrence found near Ice Lake. The occurrence consisted of seven hundred individuals in 28 m² (0.01 acres). All plants were treated by the Academy.
- CNHP visited this site in 2011 and located and pulled one individual.

- The 2012 mapping project misidentified two additional sites while the original site was still free of this weed.
- No plants were observed in 2012 – 2014.
- In 2015, 10 new plants were discovered at the known site and manually removed by CNHP.
- In 2016 and 2017, no plants were found. The area has been changed by flooding and landscape changes that included the addition of large boulders along the stream where the yellow spring bedstraw had been previously observed.
- In 2018, 102 shoots were found at the same location where it was originally discovered.
- In 2019, no shoots were found.
- In 2020, the known site had 640 new sprouts which were pulled. Two more follow-up visits were conducted removing 100 and 9 plants, respectively. A new site with at least 300 individuals was located along West Monument Creek and flagged for herbicide application.
- In 2021, all three known sites were visited in the spring and sprouts were present at all three sites.
- In 2022, no surveys or treatments were undertaken.
- In 2023, two new locations were found to have yellow spring bedstraw, one of which had an estimated population of 6,000 individuals and accounts for the vast majority of the increase.
- In 2024, during basewide mapping at the Academy seven new locations of yellow spring bedstraw were found on West Monument Creek. One new location was found in the forested upland south of the creek.
- In 2025, two sites were mapped and treated where the populations of yellow spring bedstraw are small and native plant diversity is high.



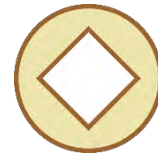
Map 32. Distribution of yellow spring bedstraw at the Academy between 2010 and 2025.



Map 33. Distribution of yellow spring bedstraw at the Academy in 2025 with the reference grid.

Dame's Rocket (*Hesperis matronalis*)

Change from 2024–2025: Stable with one extant location west of I-25
Management Goals: Eradication
State List: B



- Escaped ornamental species (Paulus and Marshall, 2022).
- Tall, showy short-lived perennial forb (Francis et al., 2009; Paulus and Marshall, 2022)
- Reproduction only by seed (Francis et al., 2009)
- Seed longevity is not known, but will remain dormant through the winter (Francis et al., 2009)
- One plant can produce as many as 20,000 seeds (Francis et al., 2009)



Figure 30. (left) *Hesperis matronalis* leaves – Photo by NY State IPM Program at Cornell University from New York, USA, CC BY 2.0; (center) *Hesperis matronalis* fruiting and flowering – Photo by AnRo0002, CC0; (right) *Hesperis matronalis* flowering – Photo by Cbaile19, CC0

2025 Mapping Results

Dame's rocket was found at just one site on the west side of I-25, on the southern edge of the base (Figure 32, I-3, Map 35). The two sites along Kettle Creek were flooded by beaver activity for the third year and no dame's rocket plants were observed (Grids I-7 and J-7, Map 35).

Dame's rocket is known from 21 occurrences on Academy property east of I-25 and another on adjacent private property along the eastern boundary. Occurrences east of I-25 were not monitored from 2019 to 2025. The populations east of I-25 have

had numbers up to 16,871 (Table 32, Map 34, and Map 35). The I-25 corridor is under construction and many of the dame's rocket plants will likely be impacted.

Table 32. Mapping of dame's rocket at the Academy during the first pass. Dame's rocket was mapped basewide from 2002 to 2018 and since 2019 it has only been mapped on the west side of I-25.

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002	---	---	---	---
2007	---	---	---	---
2012 ¹	0.83	16,871	14	0
2013	?	?	?	?
2014	?	?	?	?
2015	0.08	280	2	14
2016	0.08	294	3	14
2017	?	?	?	?
2018	0.04	633	7	14
2019 ²	<0.01	32	1	3
2020	<0.01	32	1	3
2021	<0.01	3	1	3
2022	---	---	---	---
2023	0.00	0	0	4
2024	0.00	0	0	4
2025 ³	0.006	1	1	3

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows. Dame's rocket was mapped basewide from 2002 to 2018 and since 2019 it has only been mapped on the west side of I-25.

¹ Noxious weeds were not mapped basewide and were instead only mapped within designated mapping areas in 2012 (see Figure 3 for designated mapped areas).

² Herbicide applications were performed for this species in 2019.

³ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

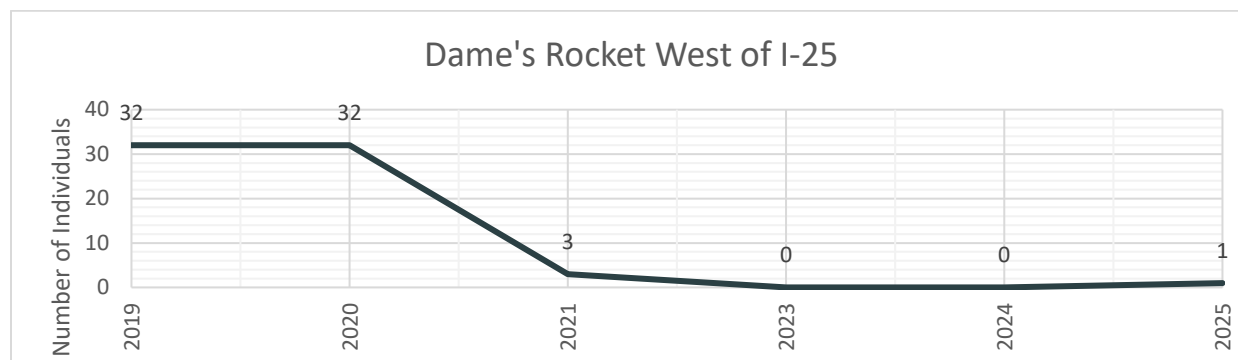


Figure 31. Number of dame's rocket individuals West of I-25 during the first pass, 2019-2024.



Figure 32. Dame's rocket on the southern edge of the base. Photo by Rob Monahan 2025.

2025 Treatment

Dame's rocket was found and treated at the one extant site on the southern edge of the base, where just a single individual was found (Figure 31, Table 33, I-3, Map 35). This individual was likely dominant for multiple years prior to its appearance in 2025.

Table 33. Monitoring and treatment of dame's rocket sites West of I-25 at the Academy in 2025.

Pass & Year	# Site Visits	# Shoots Mapped	# Manually Treated Shoots	# Sites with Plants	# Sites without Plants
2025 Pass 1	4	1	1	1	3
2025 Total	4	1	1	---	---
2019	2	0	0	---	---
2020	2	0	0	---	---
2021	4	3	3	---	---
2022	---	---	---	---	---
2023	4	0	0	---	---
2024	6	0	0	---	---
2025	4	1	1	---	---

Recommendations

Dame's rocket seed longevity is unknown, but these plants are known to remain dormant in the soil for many years (Francis et al. 2009). Thus, cutting flowering tops is recommended as well as manual removal of the entire plant. Because the seed longevity is unknown, all sites should be monitored for multiple years.

A weevil, *Ceutorhynchus inaeffectatus*, was detected in North America in 2018 and this weevil is a seed predator of dame's rocket which has suppressed seed production (Ensing et al., 2025). Although it is unlikely that this weevil is present at the Academy at this time it is possible it will arrive without human intervention and may become an asset in managing this species.

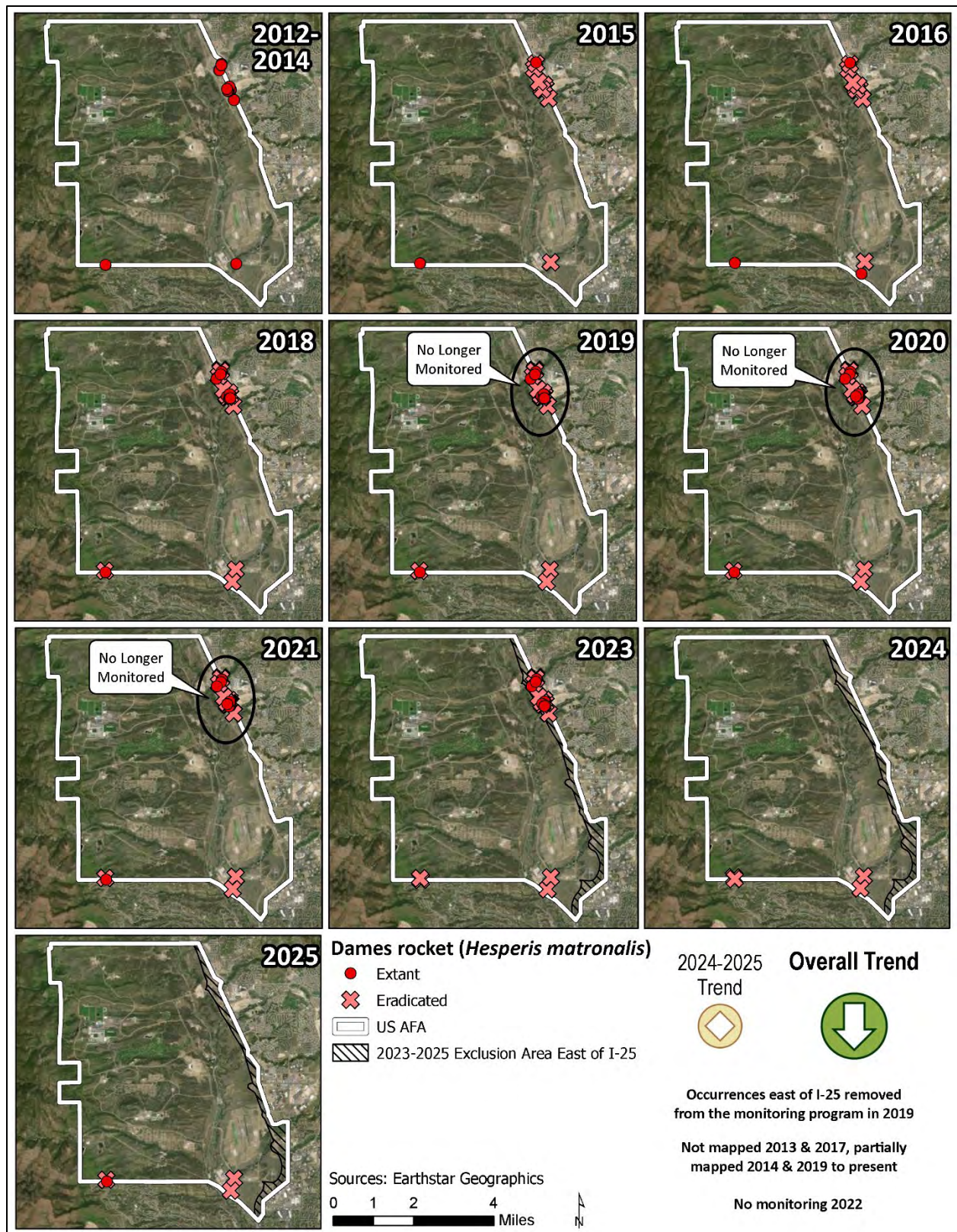
Recommendations for dame's rocket:

- Continue to monitor known sites for dame's rocket along Kettle Creek and in the southwest part of the Academy in the spring before seed set.
- Remove all vegetative parts for small populations when found.
- Monitor plants for the presence of biocontrol agents, namely the weevil *Ceutorhynchus inaeffectatus* on dame's rocket plants.

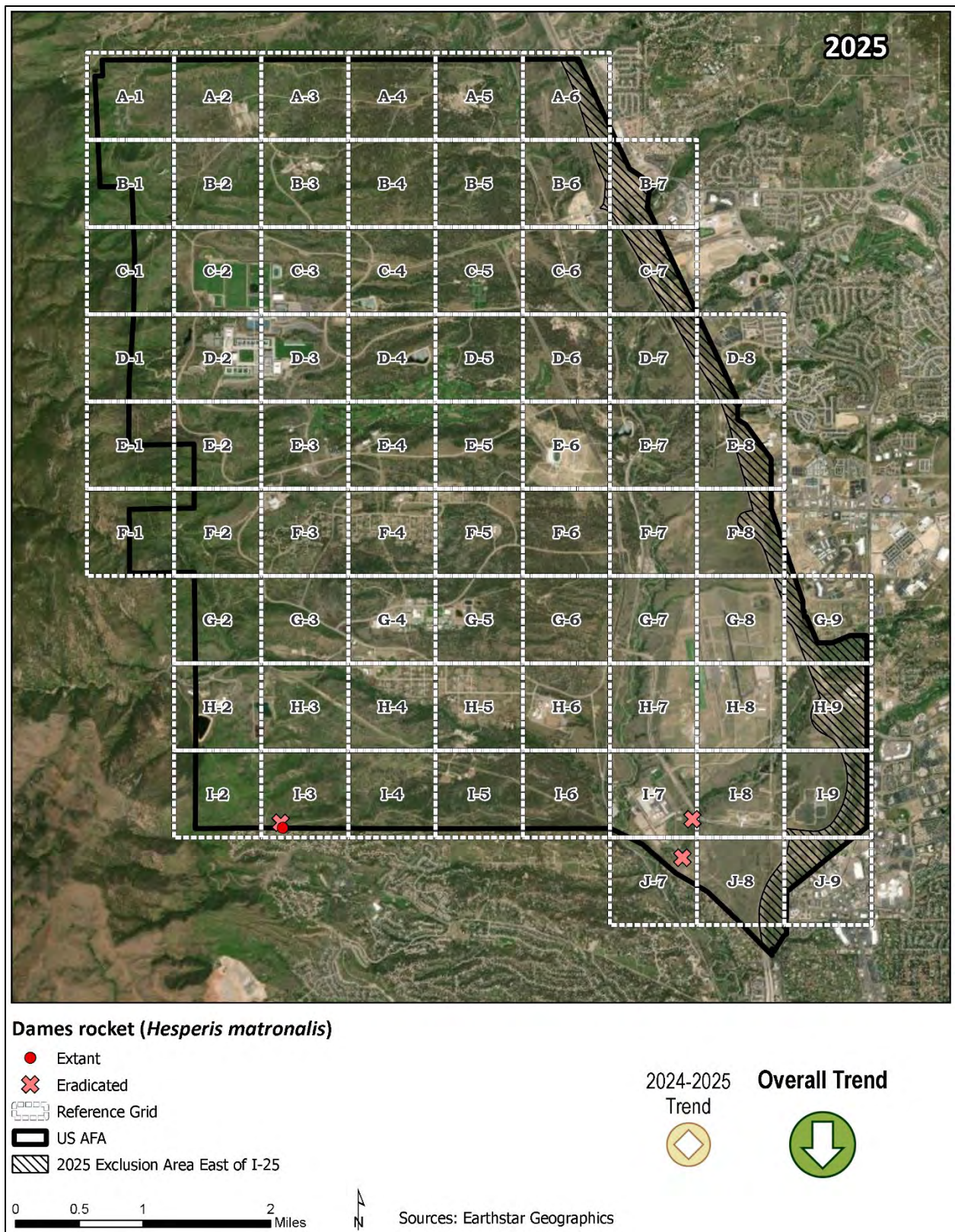
History of Sampling and Treatment:

- Dame's rocket was first discovered in 2012, near I-25. The 2012 mapping project (Rondeau and Greenwell 2013) documented 0.18 occupied acres with 16,871 shoots in 14 locations.
- Dame's rocket was not monitored in 2013 and visited too late in the season in 2014.
- In 2015, there were two extant locations out of a total of fifteen known locations. One of the locations was not visited in 2015 (south boundary location discovered in 2014 by base personnel) and presumed extant. Although plants have been impacted by herbicide application, excess overspray in the application of herbicides may be contributing to large areas of damage to adjacent native species in the natural areas.
- In 2016, two of the three known extant populations were visited by CNHP and one by Academy staff. One did not change and still contained 150 plants. The location in the southwest part of the Academy was behind a locked gate and was not visited in 2016. A new location was documented in the southeast part of the AFA in 2016 with fourteen individuals.

- In 2017, no sites were visited due to a late field start date.
- In 2018, more than half of the known locations had dame's rocket plants. No new locations were mapped.
- In 2019, only two sites west of I-25 along Kettle Creek were visited and no plants were found. The contractor sprayed thirty-two individuals at one of the two westernmost sites, and the second site was eradicated. No sites east of I-25 were visited due to construction and development activities.
- In 2020, two sites east of I-25 along Kettle Creek were visited by CNHP, one site was flooded by beaver activity and the other was eradicated. No sites east of I-25 were visited.
- In 2021, dame's rocket is decreasing at sites west of I-25 with only one site out of four monitoring sites extant (3 individuals).
- In 2022, no surveys or treatments were undertaken.
- In 2023, all sites were monitored west of I-25 and no dame's rocket individuals were found.
- In 2024, during basewide mapping at the Academy all sites were monitored west of I-25 and no dame's rocket individuals were found.
- In 2025, one individual was found and treated west of I-25. No sites were monitored on the east side of the freeway.



Map 34. Distribution of dame's rocket at the Academy between 2012 and 2025.



Map 35. Distribution of dame's rocket at the Academy in 2024 with the reference grid.

Orange Hawkweed (*Hieracium aurantiacum*)

Change from 2024–2025: Rapidly Increasing (Farish)

Management Goals: Eradication

State List: A



- Perennial
- Reproduction by seed, rhizomes, and stolons (Stone, 2010).
- Flowers from June to August
- A single flower can produce 12–50 seeds (Stone, 2010) or 100 to 1,000 seeds/plant.
- Viable seeds can be produced without pollination (Stone, 2010).
- Seeds are viable for seven years (Stone, 2010)
- Native look-a-like is orange agoseris (*Agoseris aurantica*) which can be distinguished by the hair on the leaf surface. Orange hawkweed has hispid-pustulate hairs (long stiff hairs arising from a small bump) and orange agoseris has hirsute hairs (long relatively soft hairs arising from a smooth leaf surface).



Figure 33. *Hieracium aurantiacum* found at the Farish in 2024, basal rosette (left), close up of leaf hairs (right) – Photos by Robert Monahan

2025 Mapping Results

In 2025, orange hawkweed increased from just five individuals in 2024 to 39 individuals in 2025. Orange hawkweed was previously on a steady decline at Farish Recreation Area from 2019 to 2021 with a large increase in 2023. No treatment took place in 2018 or in 2022, after which there was an increase in the number of individuals (Table 34, Table 35, Figure 34, and Map 36). The large reduction observed in 2019–2021 demonstrates the importance of same season follow-up visits and represents a very large decrease since manual treatments began.

Table 34. Mapping of orange hawkweed at Farish during the first visit.

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002	---	---	---	---
2007	---	---	---	---
2012	---	---	---	---
2017	---	---	---	---
2018	<0.01	200	1	0
2019	<0.01	600	1	0
2020	<0.01	145	1	0
2021	<0.01	59	1	0
2022	---	---	---	---
2023	<0.01	150 ¹	1	0
2024	<0.01	5	1	0
2025	<0.01	39	1	0

Farish wide weed mapping was performed in 2002, 2007, 2012, 2017, and 2025, which are the shaded rows.

¹During the first visit, we estimate the number of orange hawkweed seedlings to be 150. A plant with a similar basal rosette was present in the area and was treated in error. A total of 407 individual plants were treated though most were not orange hawkweed.

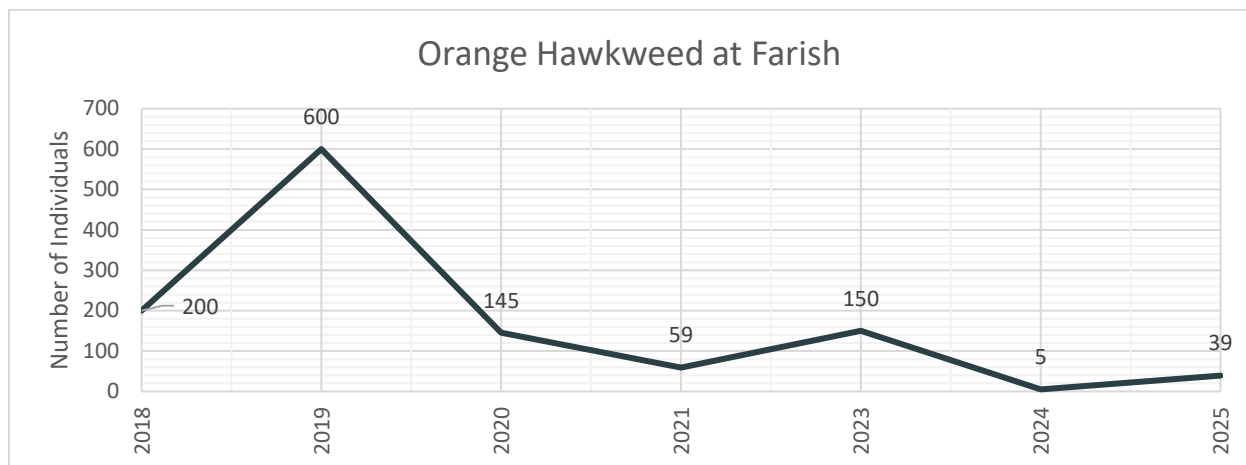


Figure 34. Number of orange hawkweed individuals mapped during the first visit, 2018–2025.

2025 Treatment

In 2025, 39 individuals were encountered in July and treated. Just one individual was flowering at the time of the visit.

Table 35. Monitoring and treatment of orange hawkweed sites at Farish in 2025.

Pass & Year	# Site Visits	# Shoots Mapped	# Manually Treated Shoots	# Sites with Plants	# Sites without Plants
2025 Pass 1	1	39	39	1	0
2025 Total	1	39	39	---	---
2019	2	1,257	1,257	---	---
2020	2	245	245	---	---
2021	2	67	67	---	---
2022	---	---	---	---	---
2023	3	193¹	193¹	---	---
2024	1	5	5	---	---
2025	1	39	39	---	---

¹During the first visit, we estimate the number of orange hawkweed seedlings to be 150. A plant with a similar basal rosette was present in the area and was treated in error. A total of 407 individuals were treated though most were not orange hawkweed.

Recommendations

The management urgency for this species is high due to the low cover and because it is only known from one site. Manual treatments have resulted in reducing the population.

Recommendations for orange hawkweed:

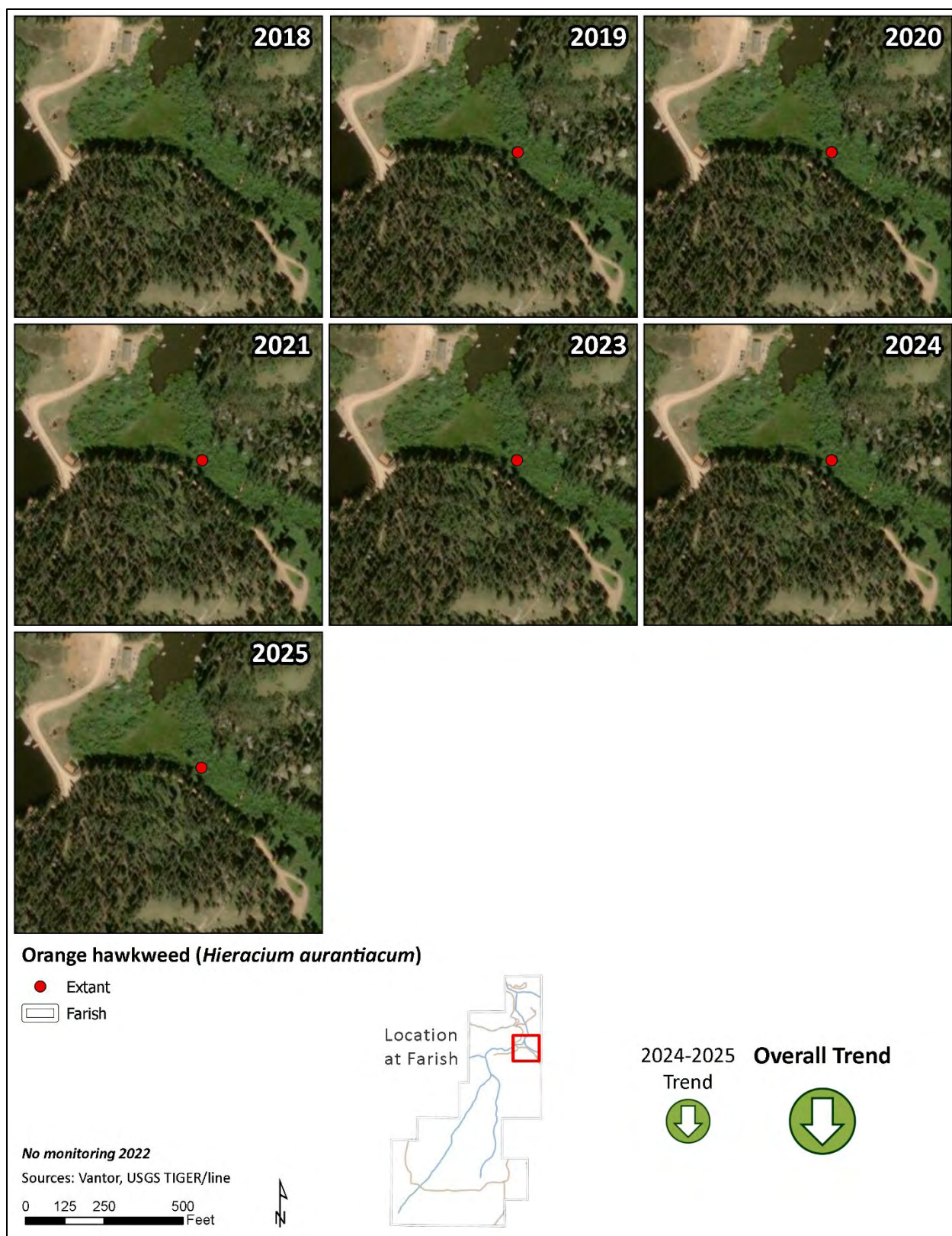
- Continue to visit the site in mid-June before flowers are produced to remove sprouts and underground parts with minimal soil disturbance.
- Re-visit the sites in August or early September to remove sprouts.

History of Sampling and Treatment:

- Orange hawkweed was first discovered at Farish on September 20, 2018, while conducting a survey of a nearby wetland in the campground area.
- In 2019, 600 plants were removed manually in the spring, followed by the removal of another 657 sprouts in late summer. No plants went to seed.
- In 2020, 145 plants were removed manually in the spring, followed by the removal of another 100 in the late summer. No plants went to seed. Only very

small sprouts less than one inch tall were observed (and removed). Two additional sites were reported by the weed contractor which were not found.

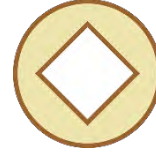
- In 2021, manual treatments have resulted in a significant decrease from past years.
- In 2022, no surveys or treatments were undertaken.
- In 2023, there was a population increase which is likely due to the lack of treatment in 2022. An estimated 193 individuals were mapped and treated manually.
- In 2024, treatment took place in August where four sprouting individuals were found and one adult individual.
- In 2025, treatment was done in July and 39 individuals were found and treated, one of which was flowering.



Map 36. Close-up of orange hawkweed at Farish between 2018 and 2025.

Common St. John's Wort (*Hypericum perforatum*)

Change from 2024–2025: Stable
Management Goals: Containment
State List: C



- Perennial forb
- Invades disturbed areas.
- Can produce fertile seeds without pollination.
- Reproduction by seed and sprouts from lateral roots and crowns (Crompton et al. 1988)
- Produces around 450 seeds per plant (Crompton et al. 1988)
- Grows in dry and wet areas in Preble's meadow jumping mouse habitat.
- Seeds viable in seed bank 20+ years
- Closely resembles native *Hypericum* species, in particular, *Hypericum scouleri* (Crompton et al. 1988) which also occurs at the Academy.



Figure 35. *Hypericum perforatum* found at the Air Force Academy in 2024 – Photos by Robert Monahan

2025 Mapping Results

In 2025, we estimate that common St. John's wort is stable at the academy as the number of shoots has increased slightly since 2024 but the occupied area and number of extant sites has decreased slightly. The estimated number of shoots went

from a little over 16,000 in 2018 to a little under 9,000 in 2021 and is at 6,730 in 2025 (Table 36, Figure 36, Map 37, and Map 38).

Table 36. Mapping of common St. John's wort at the Academy during the first pass.

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002 ¹	<0.10	363	5	---
2007	0.86	44,647	8	0
2008	1.07	130,371	13	0
2009	2.02	95,883	21	2
2010	1.47	82,733	20	6
2011	1.44	87,128	26	5
2012 ²	1.16	83,115	29	10
2013	0.85	2,621	22	21
2014	1.12	3,604	33	19
2015	1.27	3,102	27	29
2016	1.02	6,717	32	27
2017	1.31	4,202	47	23
2018	1.26	16,416	57	27
2019	1.41	11,543	74	28
2020	1.29	8,987	65	39
2021	1.41	8,766	62	40
2022	---	---	---	---
2023	1.70	4,106	61	44
2024	1.77	5,458	68	45
2025 ³	1.69	6,730	64	50

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹2002 values from field notes, not adequately mapped in GIS.

²Noxious weeds were not mapped basewide and were instead only mapped within designated mapping areas in 2012 (see Figure 3 for designated mapped areas).

³Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

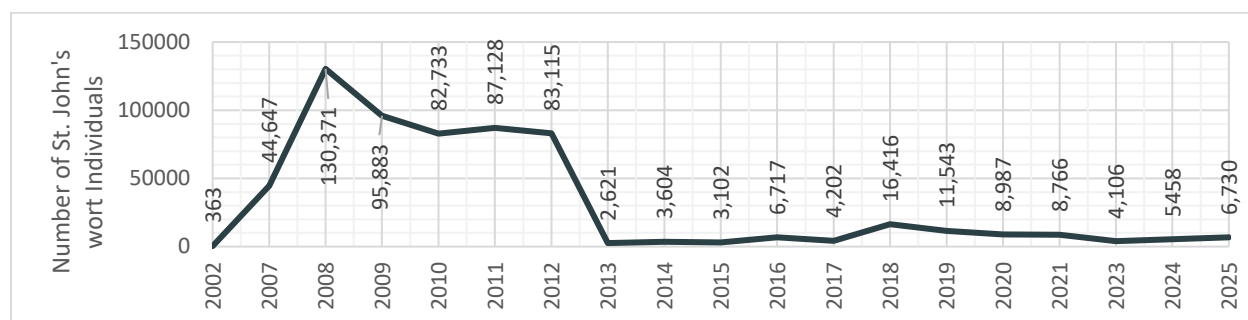


Figure 36. Number of common St. John's wort individuals mapped during the first pass, 2002-2025.

2025 Treatment

In 2025, a total of 79 sites were visited for monitoring and treatment out of 112 known sites. Of those 52 were extant and contained 5,146 shoots. A total of 2,621 shoots were manually treated (Table 37). Biocontrol agents, specifically Saint John's wort beetle (*Chrysolina hyperici*), were present at Kettle Creek (Figure 37, I-7 & I-8, Map 38) and at the seep in Jack's Valley East (B-6, Map 38).

Table 37. Monitoring and treatment of common St. John's wort sites at the Academy in 2025.

Pass & Year	# Site Visits	# Shoots Mapped	# Manually Treated Shoots	# Site with Plants	# Sites without Plants
2025 Pass 1	79	5,146	2,589	52	27
2025 Pass 2	2	31	32	2	0
2025 Total	81	5,177	2,621	---	---
2019	151	17,904	3,482	---	---
2020	102	9,658	1,858	---	---
2021	64	2,630	1,803	---	---
2022	---	---	---	---	---
2023	103	3,885	1,727	---	---
2024	119	5,425	4,569	---	---
2025	81	5,177	2,621	---	---

Recommendations

The management urgency for common St. John's wort is moderate. The active floodplain of Kettle Creek as well as some of the upper benches, are prone to infestations of common St. John's wort. The floodplain areas are easily invaded if the soils are disturbed. Large numbers of plants are removed during flooding events and washed downstream. In addition, biocontrol organisms are present and active at the Academy. Continued manual treatments could continue for small, isolated sites as long as nearby vegetation is protected from treatments; biocontrols are most effective for large populations.

- Continue to monitor all or most of the populations and look for biocontrol agents, i.e., Saint John's wort beetle (*Chrysolina hyperici*) (Figure 37).
- Manually treat small, isolated populations.
- Consider not treating larger populations with biocontrol organisms present.
- Protect intact habitats in the vicinity of common St. John's wort (Figure 38).



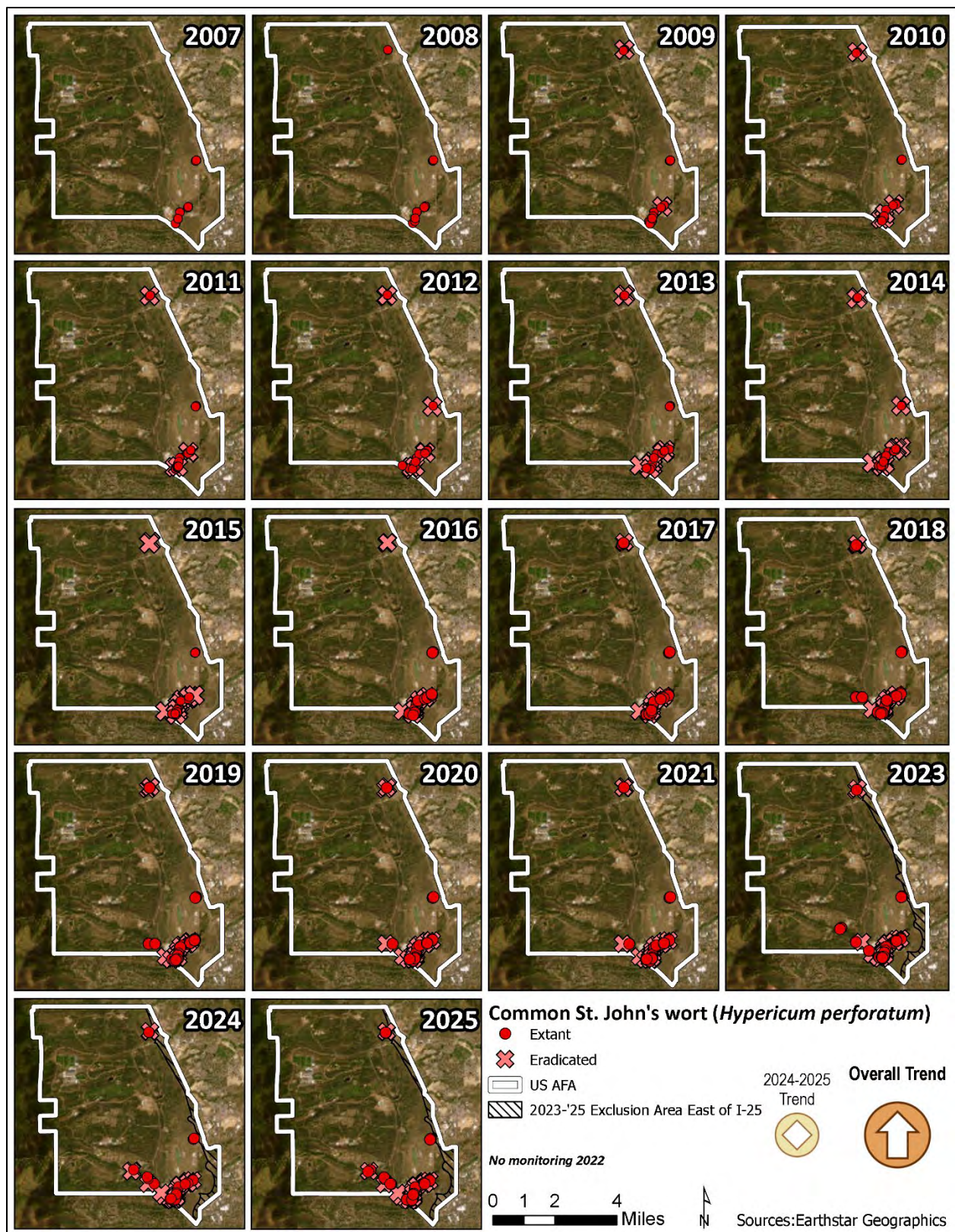
Figure 37. Saint John's wort beetles (*Chrysolina hyperici*) found on common Saint John's wort at Jack's Valley East in 2025 (left) and along Kettle Creek in 2024 (right) – Photos by Robert Monahan.



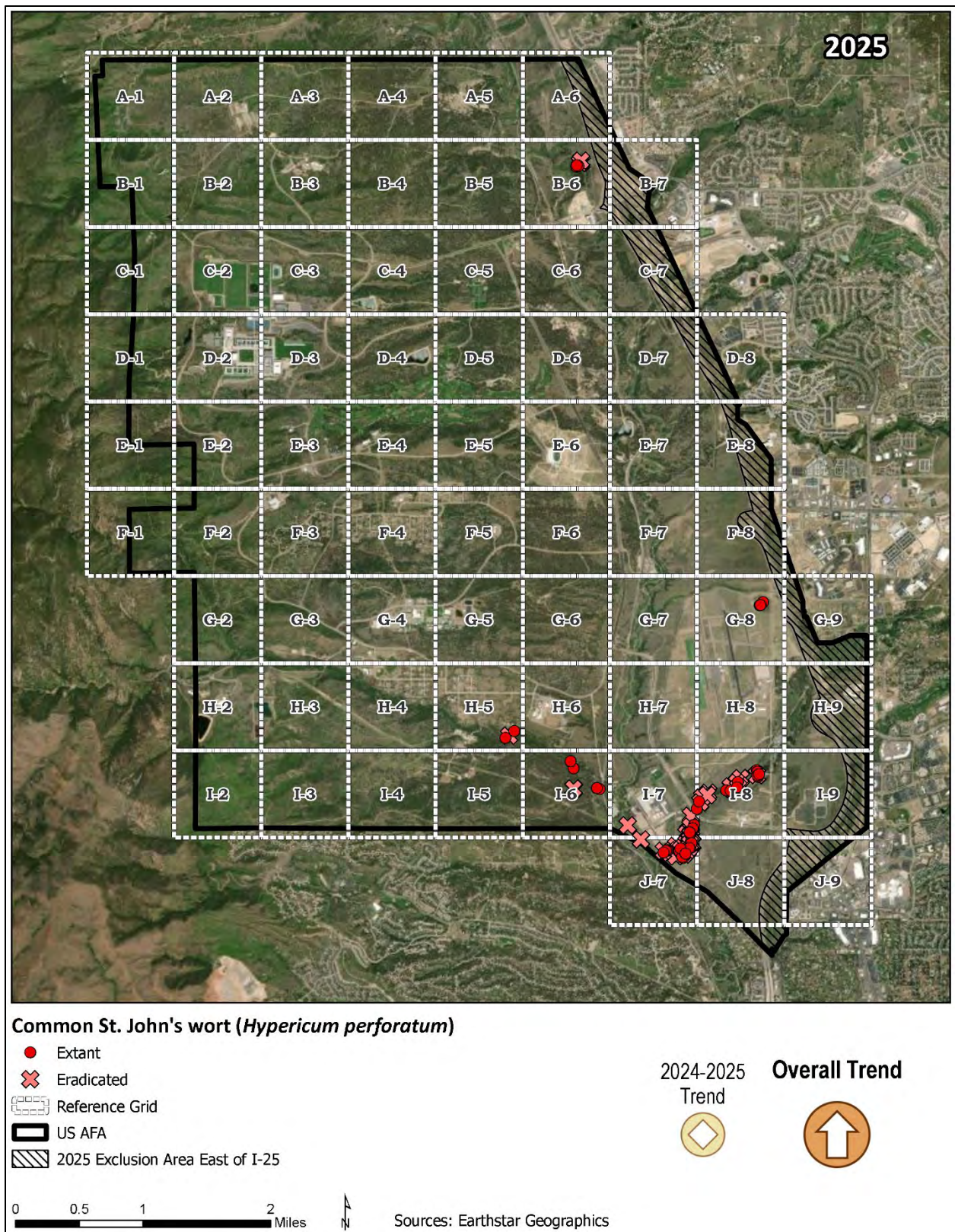
Figure 38. Native grasslands like this one along the Kettle Creek floodplain are thought to prevent the spread of noxious weeds like common St. John's wort—Photo by P. Smith, Sept. 2019.

History of Sampling and Treatment:

- Common St. John's wort was first seen at the Academy in 2002 but was described in field notes and not comprehensively mapped using the GPS.
- Common St. John's wort was added to the monitoring list in 2007.
- The populations peaked in 2008–2009.
- Biocontrol efforts were discontinued in 2010.
- A significant decline occurred in 2012–2013, with a small spike in 2016.
- In 2017, the numbers of individuals declined while the number of extant sites increased.
- In 2018, basewide mapping showed an increase in the number of individuals and mapped features while the occupied acres remained relatively stable.
- In 2019, there was a decrease in the number of shoots compared to 2018 with a slight increase in occupied acres. Biocontrol organisms were observed at multiple sites.
- In 2020, there was a slight increase in the number of shoots compared to 2019. Biocontrol was observed at many sites and herbicide treatments were being applied.
- In 2021, 50% of the sites were mapped and all but two were manually treated. A comparison between the same sites in 2020 shows a decrease in the number of individuals.
- In 2022, no surveys or treatments were undertaken.
- In 2023, all sites were monitored and select sites were not manually treated if manual treatment was not feasible due to the large population size.
- In 2024, during basewide mapping at the Academy all sites were monitored, and more individuals were treated this year than any other previous year. Saint John's wort beetle was found on many individuals on Kettle Creek.
- In 2025, seventy-nine sites were visited with most treatments focused on the population in Jack's Valley East and small populations along Kettle Creek.



Map 37. Distribution of common St. John's wort at the Academy between 2007 and 2025.



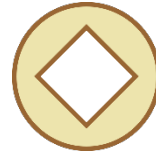
Map 38. Distribution of common St. John's wort at the Academy in 2025 with the reference grid.

Hoary Cress (*Lepidium draba*)

Change from 2018–2025: Stable

Management Goals: Containment

State List: B



- Reproduces by seeds and extensive root system (Francis and Warwick, 2008).
- Can produce 1000–5000 seeds per plant (Francis and Warwick, 2008).
- Seed longevity is 3 years (Francis and Warwick, 2008).
- Flowers May–June
- Grows to two feet tall with root depths to thirty-two inches.
- Prefers disturbed alkaline soils.



Figure 39. (left) *Lepidium draba* leaf – Photo by Harry Rose from South West Rocks, Australia, CC BY 2.0; (right) *Lepidium draba* in full flower and beginning to develop to seeds – Photo by Michelle Washebek, CNHP

2024–2025 Mapping Results

Overall, the mapping metrics indicate stable trends for hoary cress. The 2024–2025 mapping data show a small increase in the number of extant features and occupied area since 2018 and a decrease in the number of shoots (Table 38, Map 39, and Map 40). Although there were significantly more features mapped in 2025 compared to 2002, the numbers of shoots decreased slightly.

Table 38. All mapping of hoary cress at the Academy.

Year	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2002¹	20.47	1,671,728	164	0
2007	12.76	1,035,489	241	0
2012²	13.08	828,036	203	77
2018	19.52	1,707,408	300	58
2024³	28.55	1,601,467	329	64
2025⁴	28.48	1,558,419	323	83

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹2002 values are sums of 2002 and 2003 mapping.

²Noxious weeds were not mapped basewide and were instead only mapped within designated mapping areas in 2012 (see Figure 3 for designated mapped areas).

³Noxious weeds were not mapped east of I-25 in 2024 due to ongoing construction. 4 hoary cress features which are east of I-25 were excluded from the 2024 mapping and analysis.

⁴Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

Recommendations

Target newly established satellite populations for control efforts. Hoary cress, like many deep-rooted perennial species, is difficult if not impossible to control once it has become established. It is thought that targeting newly established satellite populations is more effective for control, while the established populations should be monitored for expansion.

There are no state-approved biocontrol organisms currently available for hoary cress. It is important to consider that difficult to control species can naturally decline over time (Norris 1999) and hoary cress may have saturated the habitat

where it can be found at the Academy. Continued monitoring without herbicide applications can help determine if this is occurring at the Academy.

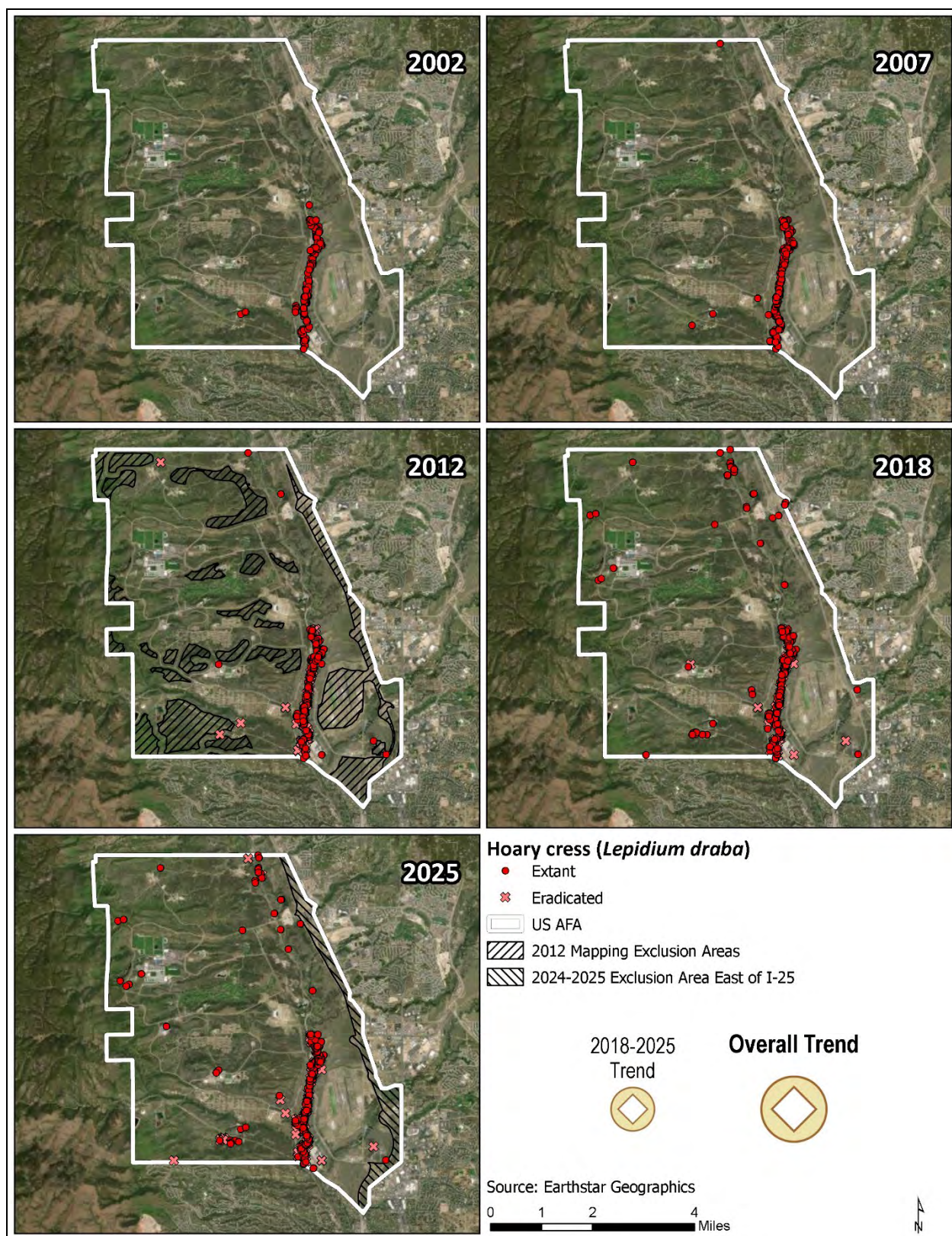
A backpack hand-held sprayer or wick method are recommended for natural areas if chemical treatments are used (only recommended for satellite populations), especially in areas known to contain resources of conservation concern and where the native vegetation needs to be protected or where smooth brome is in the vicinity (Smith et al. 2015). The most important consideration for this species at the Academy is to determine if populations are expanding, stable or naturally decreasing. Treatments have the potential to increase smooth brome coverage or that of other invasive species, if they are not carried out with care to protect surrounding native vegetation, wetlands, and intact soils. Another consideration is that the seed sources are constantly entering Monument Creek from the developed areas to the east and the scouring from frequent flooding is causing a disturbance zone that allows for increases in weeds.

History of Sampling and Treatment:

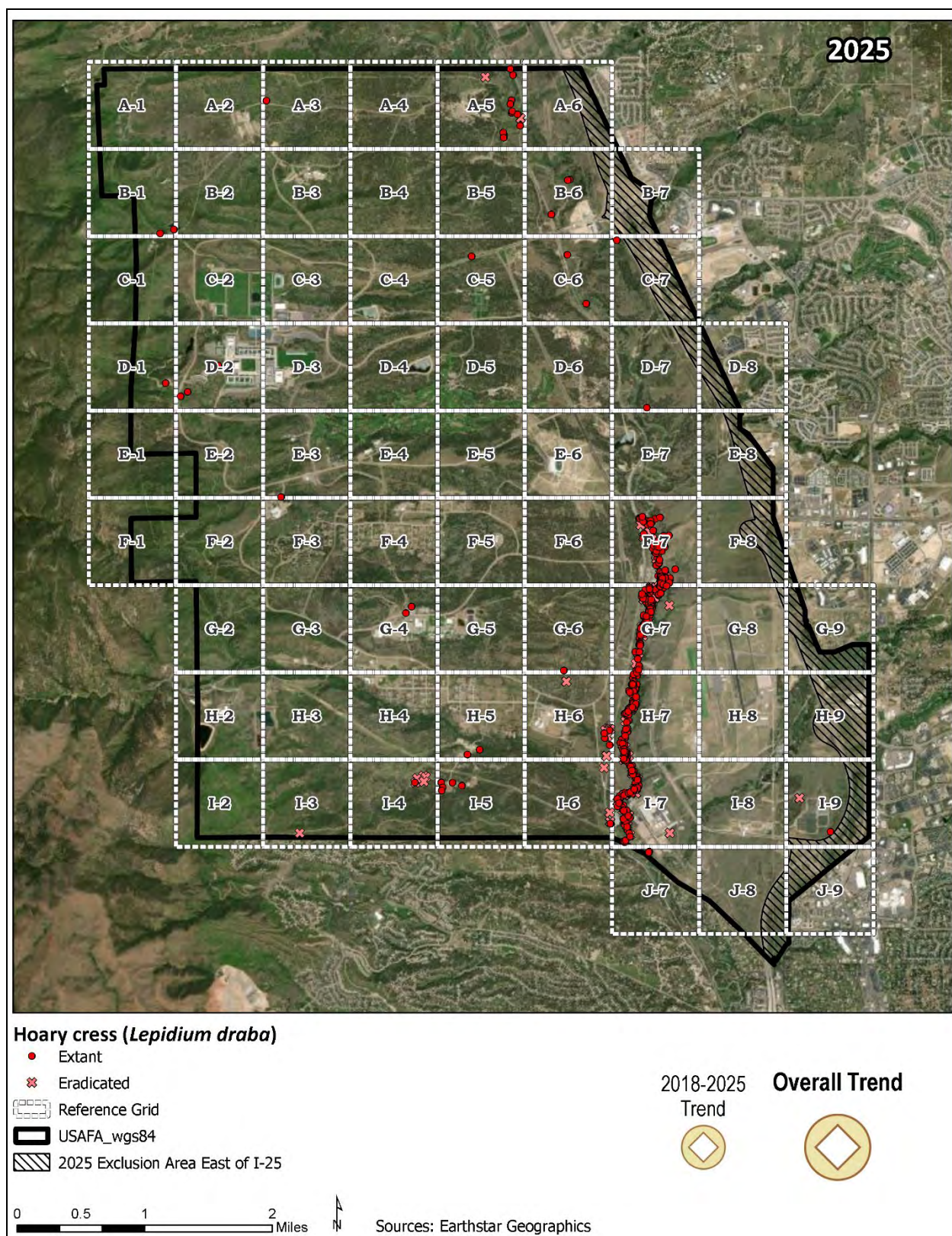
- In 2002, hoary cress was mostly concentrated along Monument Creek in the south half of the Academy (Anderson et. al. 2003).
- Extreme drought in 2002 followed by relatively average precipitation in 2003 necessitated a second year of mapping in 2003.
- In 2007, a lone occurrence was identified along Monument Creek on the north end of the Academy (Anderson and Lavender 2008b).
- In 2012, eight random sites known to have hoary cress in 2007 were used to establish eight permanent plots.
- Census mapping for hoary cress distribution across the Academy property was conducted in 2002, 2007, and 2012.
- In 2013, seven of the eight plots were monitored. Frequency was stable between 2012 and 2013, density increased from 2012 to 2013. The average cover of hoary cress increased from 2012 to 2013. Herbicide was partially applied to CADR-2 and CADR-3 after 2013 field site visit.
- No plots were monitored in 2014.
- Seven of the plots sampled in 2013 were resampled in 2015. Three new additional plots were established to bring the total number of plots to ten. The

average frequency and average density were both lower than 2012–2013; the percent average cover was the same as 2013.

- Ten plots were sampled in 2015. The frequency decreased in CADR-2, average density decreased in CADR-1 and CADR-7 and the percent cover decreased in CADR-1, CADR-2, CADR-7, and CADR-8. Everything else remained stable with no increases detected.
- Ten plots were sampled in 2016. The overall trend was stable for nearly all plots for frequency, average density and percent cover. There was an overall decrease in frequency in CADR-2 and a decrease in percent cover for CADR-7.
- No plots were monitored in 2017 due to late start date for field work.
- In 2018, basewide weed mapping was conducted across the Academy that included the census species from 2013. Ten permanent plots were monitored. Herbicides were applied in many areas with partial treatments due to thick plant growth. Some areas were chemically treated to bare soil.
- In 2024, basewide mapping at the Academy showed there was a small increase in the occupied area and number of features along with a decrease in the total number of shoots. No permanent plots were monitored.
- In 2025, supplementary basewide mapping was performed to capture select areas that were not mapped in the 2024 basewide survey.



Map 39. Distribution of hoary cress at the Academy from basewide weed surveys (2002, 2007, 2012, 2018, and 2024-2025).



Map 40. Distribution of hoary cress at the Academy from basewide weed survey in 2024-2025

Perennial Pepperweed (*Lepidium latifolium*)

Change from 2024–2025: Stable

Management Goals: Eradication – Rapid Response

State List: B



- Perennial (Francis et al., 2007)
- Reproduction by seed and creeping roots (Francis et al., 2007)
- Roots to nine feet deep and ten feet lateral spread
- Flowers May–July
- Each shoot can produce thousands of seed in a single season (Francis et al., 2007)
- Seeds often transported by water (Francis and Warwick, 2007)
- Seed longevity not well-known, estimated to be 2 years (Francis and Warwick, 2007).



Figure 40. (left) Basal *Lepidium latifolium* with an extensive lateral root system at the Academy – Photo by Robert Monahan 2024; (right) Mature *Lepidium latifolium* at the Academy – photo by Kate Wright 2018.

2025 Mapping Results

One new location was found in Grid A-6, which accounts for the majority of the individuals found in 2025. The two previously known perennial pepperweed locations at the Academy (Grids A-6 & I-9, Map 42) have decreased in the number of shoots in 2025 for the first monitoring pass of the season. The occupied acres increased greatly due to the new population found this year (Table 39, Figure 41, Map 41, and Map 42).

Table 39. Mapping of perennial pepperweed at the Academy during the first pass

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002	---	---	---	---
2007	---	---	---	---
2012	---	---	---	---
2018	0.02	213	2	0
2019	0.03	212	2	0
2020	0.03	23	2	0
2021	0.03	4	2	0
2022	---	---	---	---
2023	0.033	99	2	0
2024	0.027	28	1	1
2025 ¹	0.156	171	2	1

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

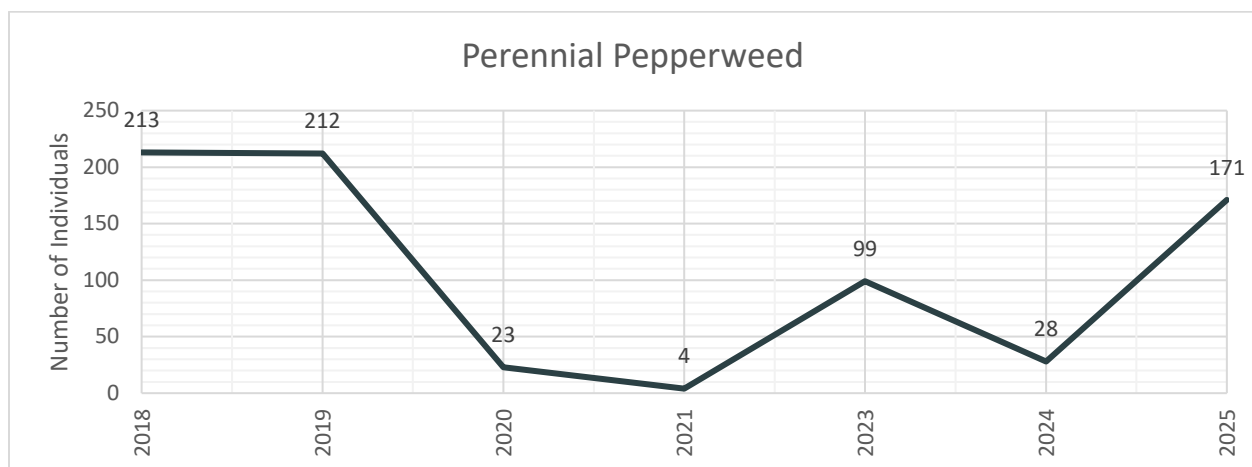


Figure 41. Number of perennial pepperweed individuals mapped during the first pass, 2018-2025.

2025 Treatment

There were 187 individuals counted and treated in 2025. The vast majority of the pepperweed found was at a new northern location (Grid A-6, Map 42). Many of the plants at the northern site were flowering. All shoots at the southern location were treated before they flowered this year (Grid I-9, Map 42). Manual treatments have shown to be effective at controlling the spread of perennial pepperweed, although populations are likely to persist with a small number of individuals due to root fragments often remaining in the soil after treatment.

Table 40. Monitoring and treatment of perennial pepperweed sites at the Academy in 2025.

Pass & Year	# Site Visits	# Shoots Mapped	# Manually Treated Shoots	# Sites with Plants	# Sites without Plants
2025 Pass 1	3	171	171	3	0
2025 Pass 2	3	16	16	1	2
2025 Total	6	187	187	---	---
2019	8	6	6	---	---
2020	6	114	114	---	---
2021	8	179	179	---	---
2022	---	---	---	---	---
2023	8	253	253	---	---
2024	4	55	55		
2025	6	187	187	---	---

In 2019, CNHP flagged plants for herbicide treatment. Plants re-sprouted later in the season (Figure 42) and again from 2020 to 2025. The sites have been treated manually multiple times a season to remove sprouts and vegetative sprouts of plants that come up throughout the growing season since the herbicide was applied. The off-target damage was limited during the herbicide application for the southern site, protecting native grasses in the vicinity of the pepperweed plants. However, at the northern site, patches of dead native grasses and forbs in the overspray zone have been replaced with Canada thistle, other non-native grasses, and bare soils (Figure 43).



Figure 42. Two top-killed perennial pepperweed plants (left) that sprouted leaves and flowers later in summer of 2019 (right)—Photos by Pam Smith



Figure 43. Perennial Pepperweed herbicide treatment one-year post application (left) at northern site, shows overspray area killing nearby native species and leaving open soils in 2019. Two years post herbicide application at the same site (right), shows Canada thistle and other non-native species invading the overspray area in 2021—Photos by Pam Smith

Recommendations

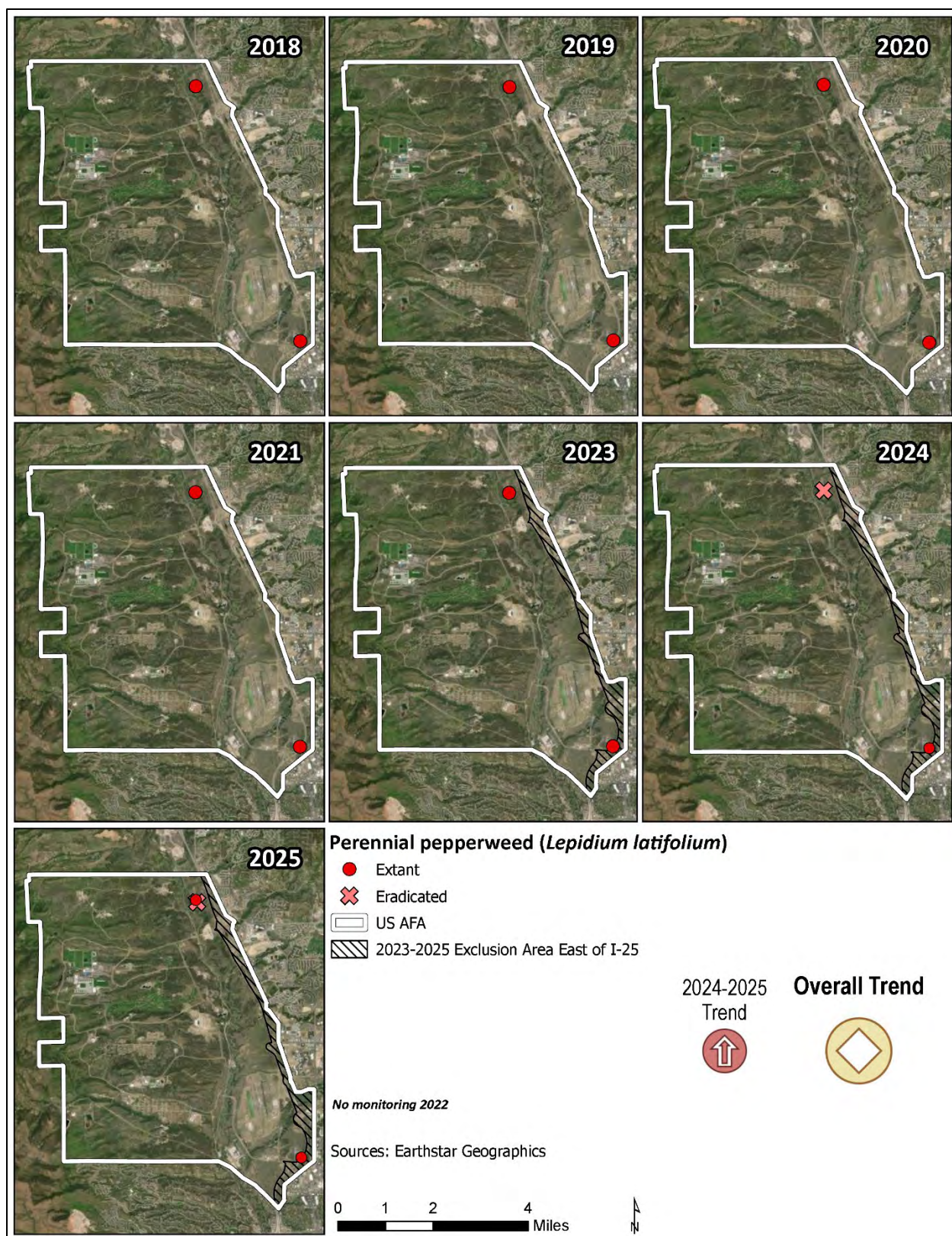
The management urgency for perennial pepperweed is high. This species has the potential to get out of control quickly and form dense colonies due to its deep root system and prolific seed production. To manage this species, the root reserves need to be depleted and seed production stopped. In addition, the protection of surrounding plants, especially native grasses, is important in preventing spread/invasion (Young et al. 2002). The populations at the Academy are of a practical size to treat manually. Treatments have been effective at containing and suppressing the populations.

- Continue to monitor known sites throughout the growing season.

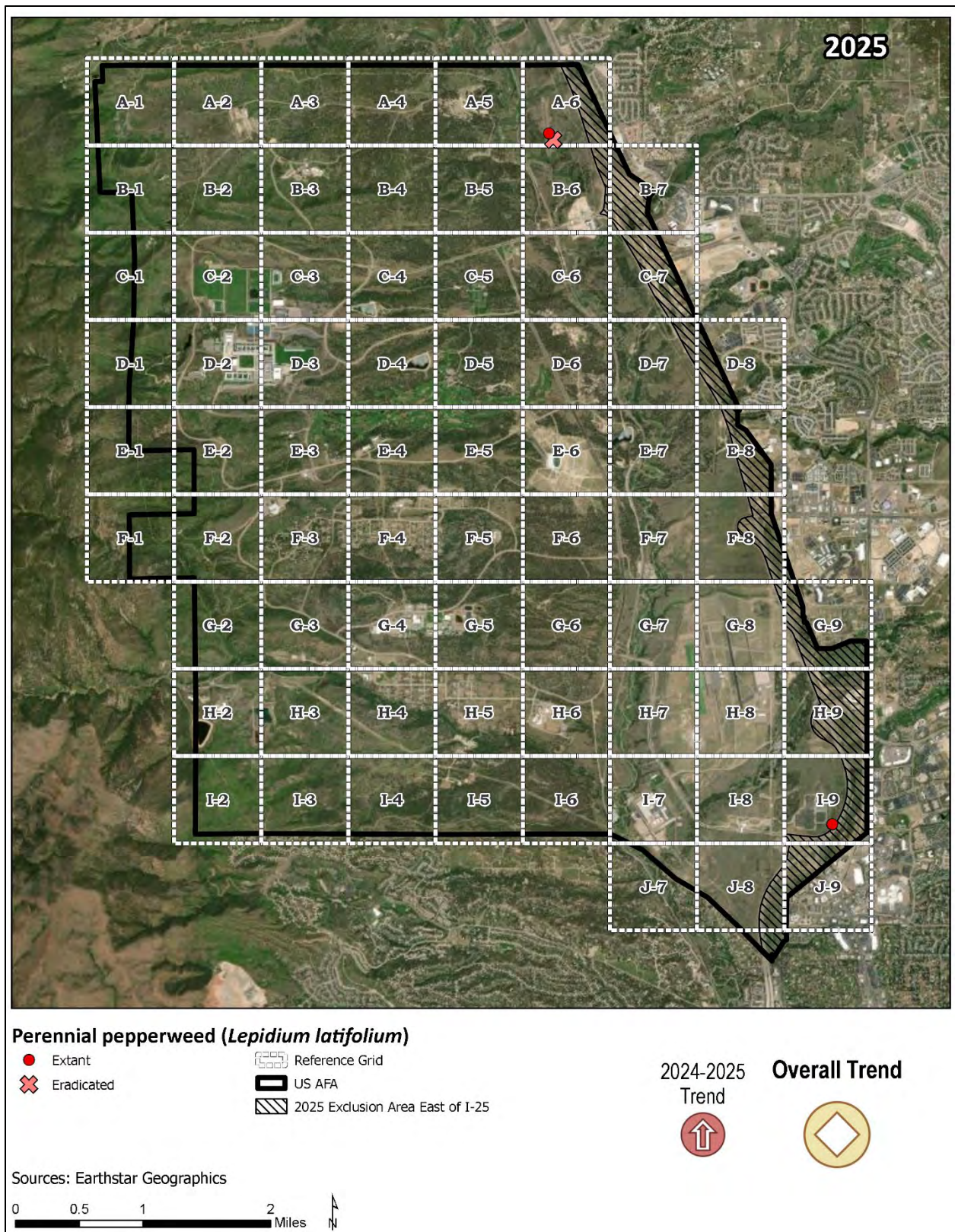
- Remove as much of the plant and root system as possible with minimal soil disturbance.
- Revisit all sites multiple times to prevent plants from going to seed.

History of Sampling and Treatment:

- Perennial pepperweed was first documented by CNHP during the 2018 basewide weed survey, although herbicide treatment data suggest it has been present since 2015.
- In 2019, the number of shoots were almost identical to 2018. All plants were treated with herbicide in early summer. Six plants re-sprouted and were removed manually in late summer. No plants went to seed at the known sites in 2019.
- In 2020, there was a significant decrease in plants at both known locations, and plants were prevented from going to seed.
- In 2021, perennial pepperweed increased mostly at the southern site. Plants were found sprouting in April, June, August, and September. Flowers were produced, some may have gone to seed. The increase is likely related to much higher precipitation in 2021.
- In 2022, no surveys or treatments were undertaken.
- In 2023, the southern sites near I-25 increased in individuals but not area. Plants were found throughout the season as sprouts growing from runners. One resprout was observed near Aardvark airstrip in August, so repeated visitations are necessary for all locations. No flowers were observed in 2023.
- In 2024, basewide mapping at the Academy showed the overall number of individuals decreased. All individuals were treated before they had the opportunity to flower.
- In 2025, a new location was discovered near the eradicated northern site. The two previously known locations have continued to decline, but with the additional location the species is increasing at the Academy.



Map 41. Distribution of perennial pepperweed at the Academy between 2018 and 2025.



Map 42. Distribution of perennial pepperweed at the Academy in 2025 with the reference grid.

Oxeye Daisy (*Leucanthemum vulgare*)

Change from 2024–2025: Decreasing
Management Goals: Eradication – Rapid response
State List: B



- Garden Escape
- Short-lived perennial (Jacobs, 2009b)
- Reproduction by seeds, roots, and root fragments (Jacobs, 2009b)
- Shallow root system
- Blooms June – August
- Resembles Shasta daisy (*Leucanthemum x superbum*) but much smaller (2 vs 4 ft tall, head less than 3' across vs up to 5")
- Upper leaves clasp the stem, lower leaves have petioles and are spoon shaped
- Seed longevity 38+ years (Colorado Department of Agriculture, 2015; Jacobs, 2009b)



Figure 44. *Leucanthemum vulgare* found at the Air Force Academy, flower (left) and the stem leaves (left)–Photos by Robert Monahan 2024

2025 Mapping Results

In 2025, there were no oxeye daisy found at the twelve previously extant sites or elsewhere at the Academy (Map 43, and Grids I-7 & I-8 on Map 44). Since its discovery in 2019, oxeye daisy has expanded from five known sites to twelve sites. The numbers of individuals have also decreased from 40 in 2019 to just 1 in 2024, which was found at a new location (Table 41, Map 43, and Map 44).

Table 41. Mapping of oxeye daisy at the Academy during the first pass.

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002	---	---	---	---
2007	---	---	---	---
2012	---	---	---	---
2018	---	---	---	---
2019	<0.01	40	5	---
2020	0.02	455	6	3
2021	0.02	616	7	4
2022	---	---	---	---
2023	0.02	390	5	6
2024	0.0008	1	1	11
2025 ¹	0	0	0	12

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

2025 Treatment

No oxeye daisy plants were found or treated in 2025 (Table 42). This species is only known from Kettle Creek where beaver activity is high. Beavers have been responsible for flooding some of the known oxeye daisy locations.

Table 42. Monitoring and treatment of oxeye daisy sites at the Academy in 2025.

Pass & Year	# Site Visits	# Shoots Mapped	# Manually Treated Shoots	# Sites with Plants	# Sites without Plants
2025 Pass 1	2	0	0	0	2
2025 Total	2	0	0	---	---
2019	5	52	52	---	---
2020	15	706	706	---	---
2021	24	1,422	1,422	---	---
2022	---	---	---	---	---
2023	24	391	391	---	---
2024	13	1	0	---	---
2025	2	0	0	---	---

Recommendations

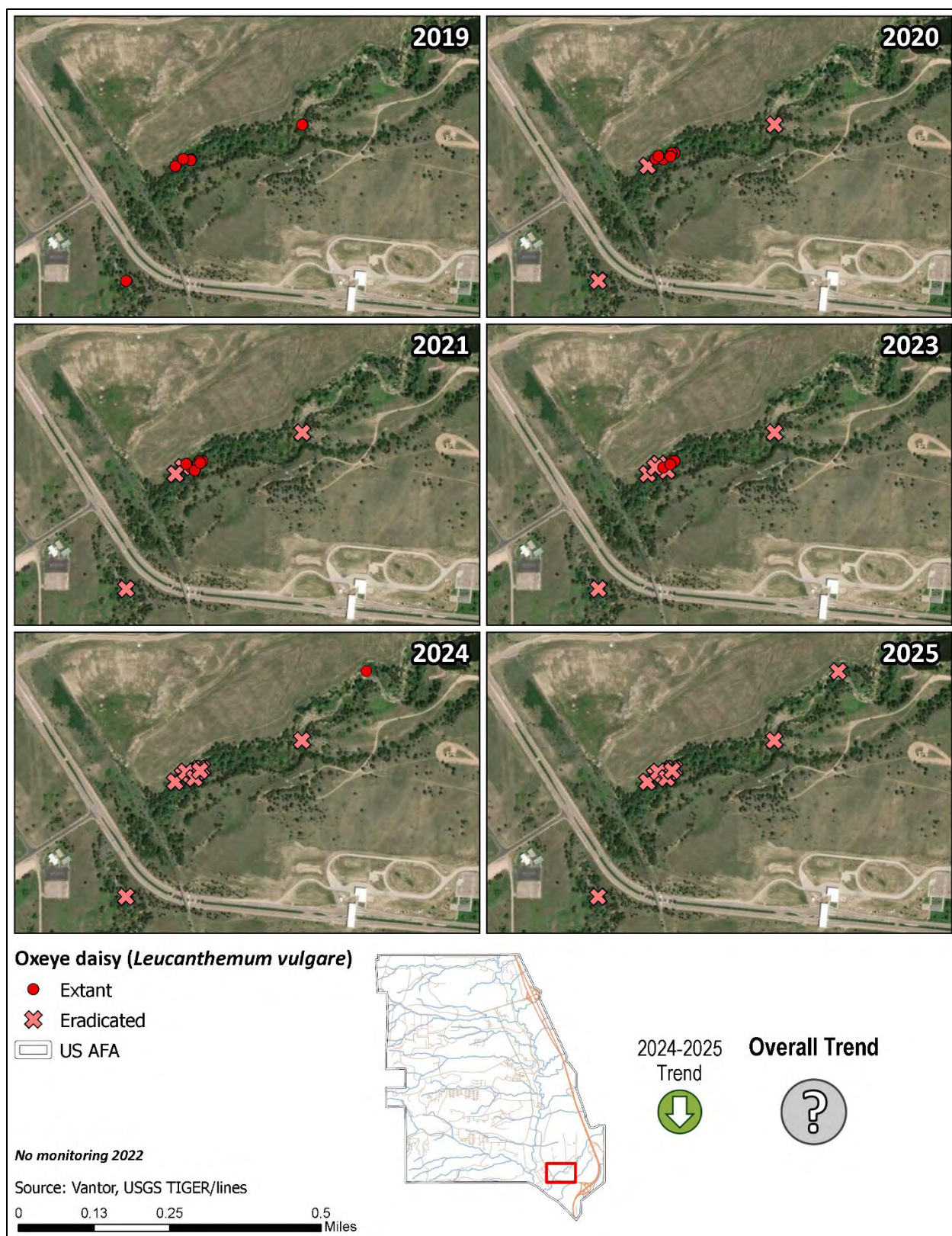
The management urgency for oxeye daisy is high. These plants are difficult to remove, and rapid response is extremely important to control in the early stage in the infestation. At this point eradication seems possible but could get out of hand quickly without yearly multi-season surveys and treatment. Same season follow-up is essential to keep this species from increasing due to the continuous sprouting. The source of seeds is most likely residential properties as oxeye daisy commonly escapes from gardens to wild lands. It is a short-lived perennial that can reproduce via both root fragments and seeds and can spread quickly. The seed longevity is extremely long. However, the shallow root system and low number of individuals observed makes manual removal a viable option (Colorado Department of Agriculture, 2015; Jacobs, 2009) and continual monitoring is a necessity not only at Kettle Creek but across the base to look for new occurrences.

Recommendations for oxeye daisy:

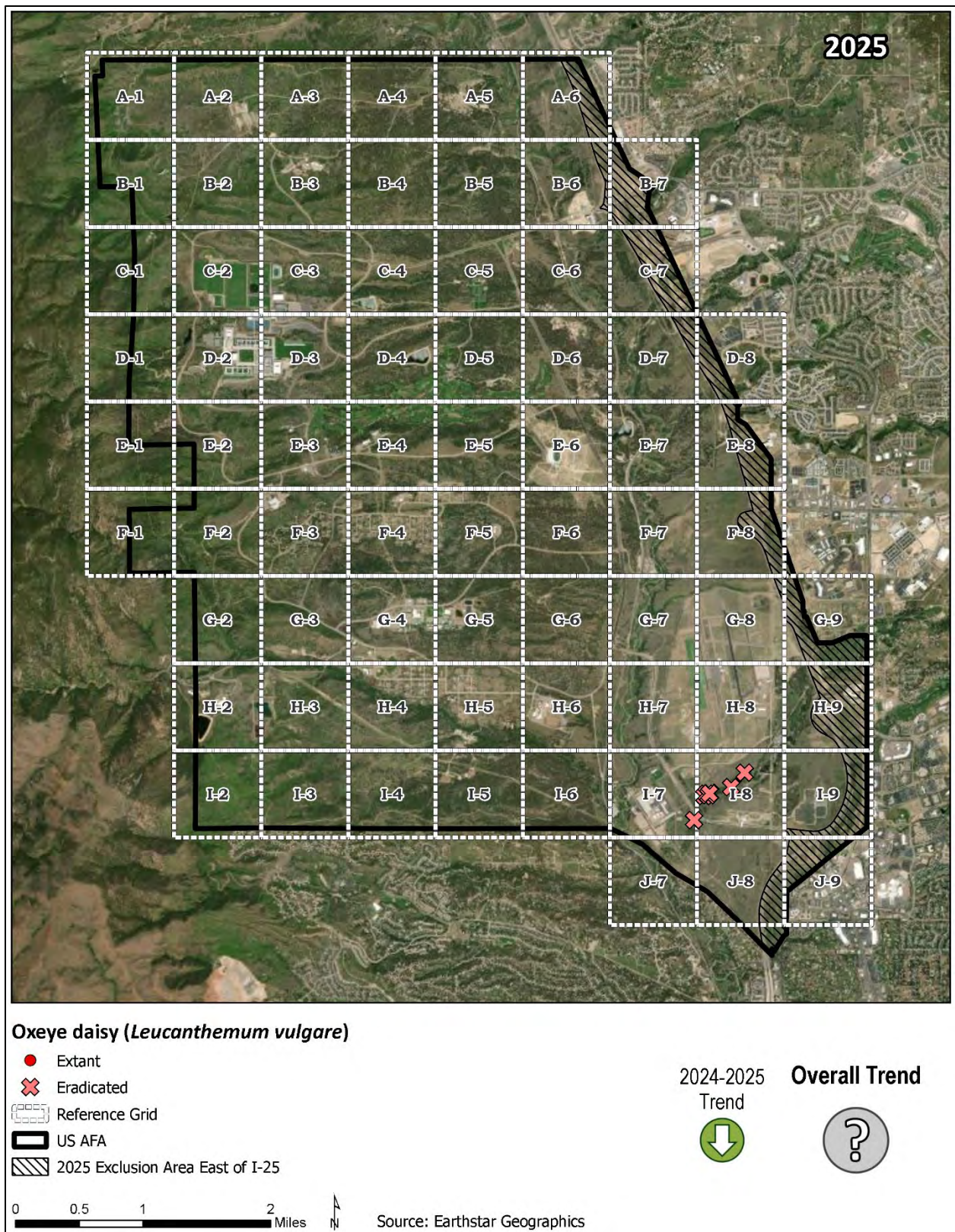
- Continue to monitor Kettle Creek multiple times during the growing season.
- Remove all plants found including roots.
- Revisit all sites at least once or twice during the season.

History of Sampling and Treatment

- 2019 is the first-year oxeye daisy has been found at the Academy. All forty individuals were removed at five features.
- In 2020, there was an increase in the number of sites from five in 2019 to nine in 2020, and an increase from 40 in 2019 to 455 shoots in 2020.
- In 2021, oxeye daisy continued to increase. The higher precipitation received in 2021 may have influenced the higher number of sprouts compared to 2020.
- In 2022, no surveys or treatments were undertaken.
- In 2023, oxeye daisy drastically decreased since 2021. This trend occurred from the increased precipitation and beaver activity in Kettle Creek. Lots of new dams and activity were seen in 2023.
- In 2024, during basewide mapping at the Academy one new location was discovered containing a single individual. A majority of visits took place in September, possibly missing the optimal window to find oxeye daisy and no other oxeye daisy were found.
- In 2025, no oxeye daisy was found at the Academy.



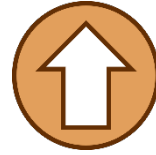
Map 43. Distribution of oxeye daisy at the Academy between 2019 and 2025.



Map 44. Distribution of oxeye daisy at the Academy in 2025 with the reference grid.

Dalmatian Toadflax (*Linaria dalmatica*)

Change from 2024–2025: Increasing
Management Goals: Eradication, Rapid Response
State List: B



- Perennial forb
- Adapted to survive in a wide range of habitats and conditions (Vujnovic and Wein, 1997).
- Escaped ornamental plant (Vujnovic and Wein, 1997).
- Emergence early spring, flowers May–June
- Reproduction by seeds and root buds (Zouhar, 2003a; United States Forest Service, 2017).
- Extensive root systems in established populations can make this species difficult to control.
- Seed longevity estimate to be greater than 10 years (Zouhar, 2003a; Vujnovic and Wein, 1997).



Figure 45. *Linaria dalmatica* flowers (left) and leaves (right) – Photos by Robert Flogaus-Faust (CC BY-SA 4.0) via Wikimedia Commons

2025 Mapping Results

In 2025, twelve individuals were mapped at one location and no new locations were found (Table 43, Map 45, and Grids H-2 & I-8 on Map 47). Based on past surveys, Dalmatian toadflax seems to reappear after three to five years when conditions are right. There is a correlation with annual spring-summer precipitation amounts around twelve inches and the presence of Dalmatian toadflax at the Academy.

Table 43. Mapping of Dalmatian toadflax at the Academy during the first pass.

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002	---	---	---	---
2007	---	---	---	---
2009¹	?	10	1	0
2010	0.50	107	2	1
2011	0	0	0	3
2012	0	0	0	3
2013¹	?	12	1	3
2014¹	<0.01	7	1	3
2015¹	0	0	0	4
2016	<0.01	1	1	3
2017¹	<0.01	480	1	3
2018¹	0.01	52	1	3
2019	0	0	0	4
2020	0	0	0	4
2021	0.02	2	1	4
2022	---	---	---	---
2023¹	0	0	0	5
2024	0	0	0	5
2025^{1,2}	0.01	12	1	4

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Years with spring-summer annual ppt >12".

² Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

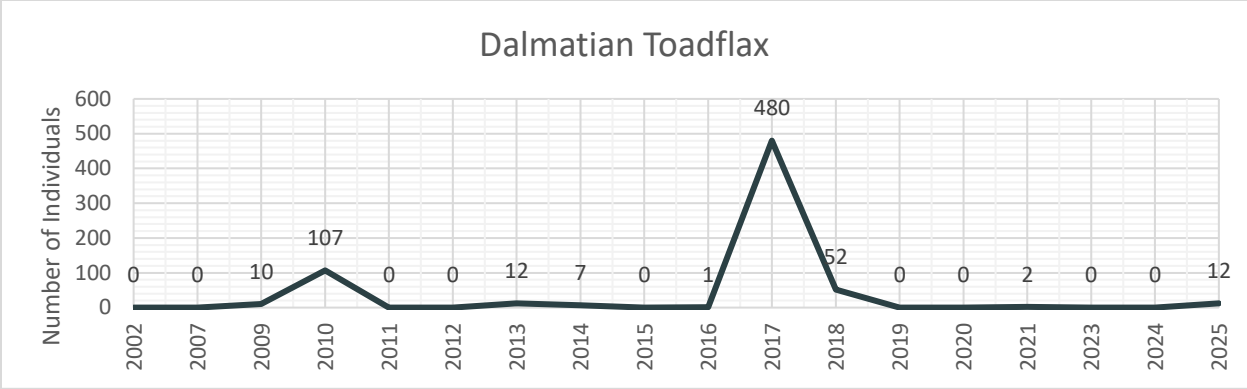


Figure 46. Number of Dalmatian toadflax individuals mapped during the first pass, 2009-2025.

2025 Treatment

In 2025, all twelve individuals that were found were manually treated. (Table 44).

Table 44. Monitoring and treatment of Dalmatian toadflax sites at the Academy in 2025.

Pass & Year	# Site Visits	# Shoots Mapped	# Manually Treated Shoots	# Sites with Plants	# Sites without Plants
2025 Pass 1	5	12	12	1	4
2025 Total	5	12	12	---	---
2019	8	0	0	---	---
2020	8	0	0	---	---
2021	14	2	2	---	---
2022	---	---	---	---	---
2023	9	0	0	---	---
2024	5	0	0	---	---
2025	5	12	12	---	---

Recommendations

The management urgency for Dalmatian toadflax is considered high. There are years when no Dalmatian toadflax are found, followed by sudden increase in the number of plants found. All but one of the years where plants have been found are correlated with higher than average spring-summer annual precipitation.

Recommendations for Dalmatian toadflax:

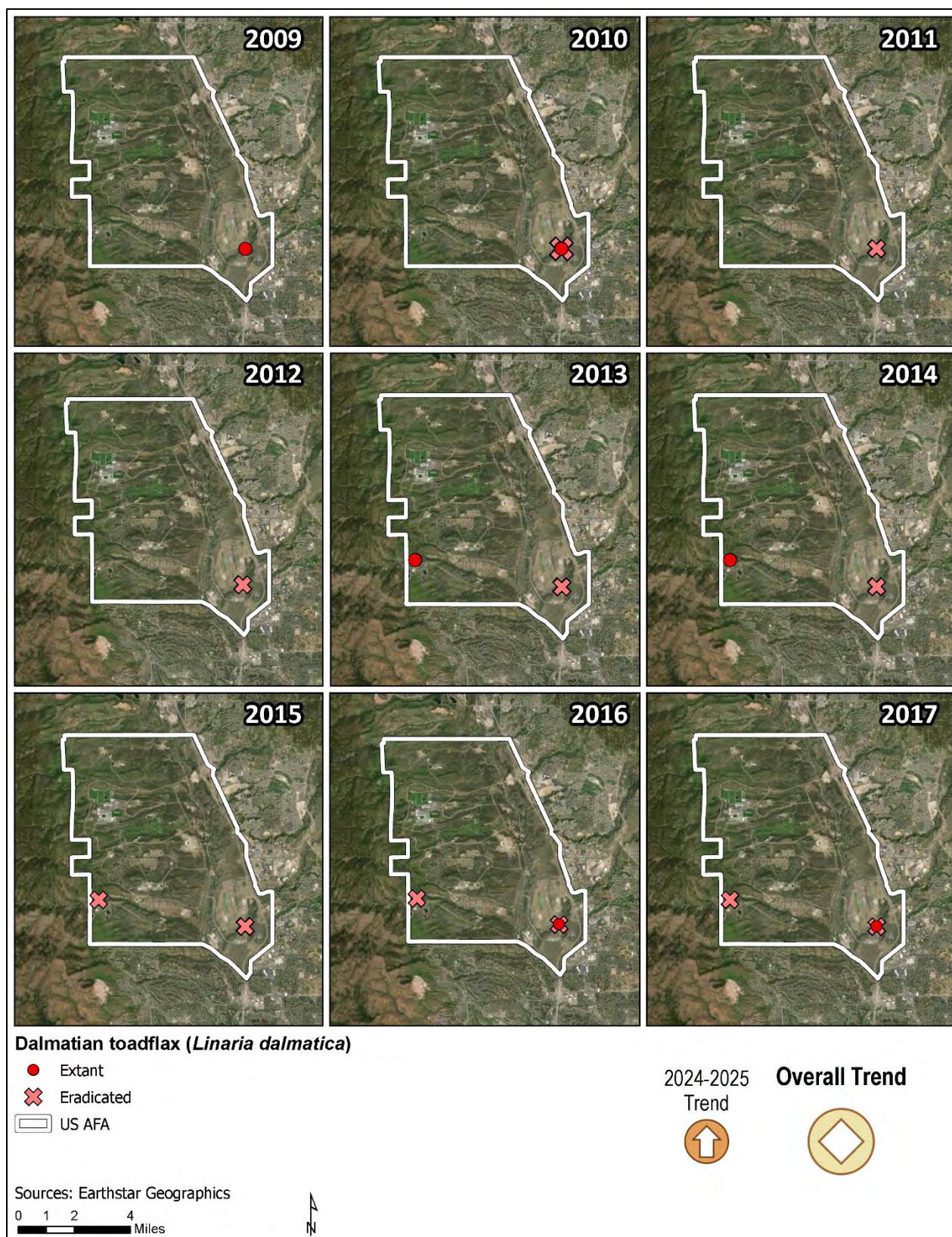
- Continue to monitor all known sites annually.
- Remove new shoots as they are found and re-visit sites with plants in the same season.

- Look out for new populations of Dalmatian toadflax around the Academy to detect them early.

History of Sampling and Treatment:

- Dalmatian toadflax was discovered at the Academy in 2009 with one occurrence found near Kettle Lake #1 near the boat ramp. The occurrence consisted of a small number of plants.
- In 2010, two patches were mapped by CNHP with 107 shoots that covered approximately 203 m² (0.05 acres). The original infestation was eradicated, but two new infestations were found very close by, just north of the original occurrence.
- The Academy treated the 2010 sites, and no plants were observed in 2011–2012.
- A new site on the western side of the Academy was discovered in 2013 which was treated immediately. This was far away from the previous infestations on the east side of the Academy near Kettle Lake #1.
- In 2014, seven plants were observed at the western known site, they were hand pulled and have not returned as of 2016 survey.
- In 2015, no plants were observed at the four known sites and no new infestations were found.
- In 2016, one individual was found (and pulled) at the original site at Kettle Lake #1 near the boat ramp.
- In 2017, there was a significant increase in a single year in the number of individuals the Kettle Lake #1 site where one plant was observed in 2016. All plants were removed by CNHP.
- In 2018, 52 plants were observed at the Kettle Lake #1 site and at no other locations.
- In 2019 no plants were observed at the four known sites.
- In 2020, no plants were observed at the four known sites.
- In 2021, two plants were observed at a new point eight meters from the closest existing mapped site, bringing the total of sites from four to five. All previously existing sites were eradicated.
- In 2022, no surveys or treatments were undertaken.
- In 2023, no plants were observed.

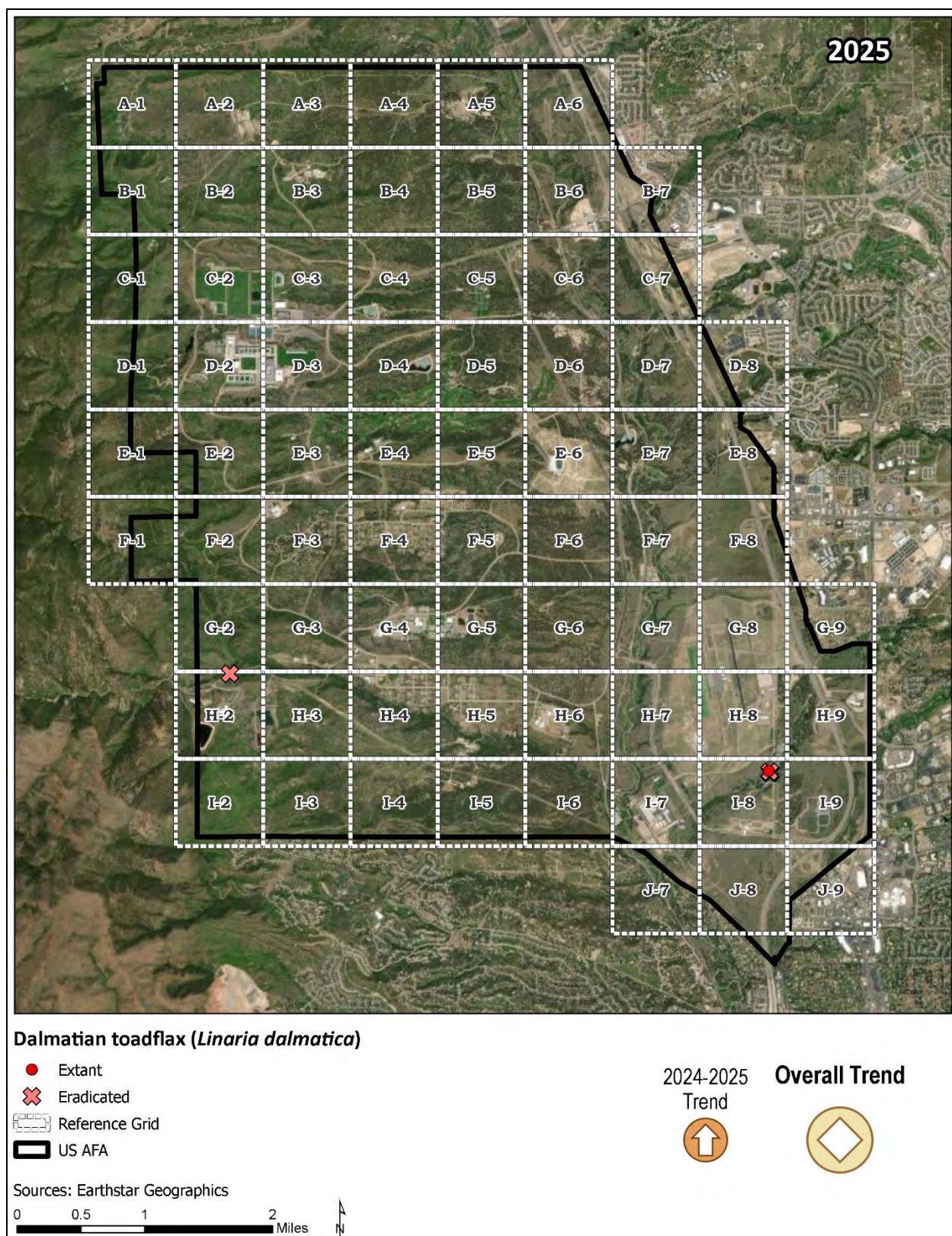
- In 2024, basewide mapping was conducted at the Academy and no plants were observed.
- In 2025, twelve plants were observed and treated at one location.



Map 45. Distribution of Dalmatian toadflax at the Academy between 2009 and 2017.



Map 46. Distribution of Dalmatian toadflax at the Academy between 2018 and 2025.



Map 47. Distribution of Dalmatian toadflax at the Academy in 2025 with the reference grid.

Yellow Toadflax (*Linaria vulgaris*)

Change from 2017–2025: Increasing Rapidly

Management Goals: Suppression

State List: B



- Reproduction from seeds, root buds, and root fragments (Saner, 1995).
- Resistant to some herbicides (Saner, 1995).
- The stem boring weevil, *Mecinus janthinus*, is a biological control agent for yellow toadflax.



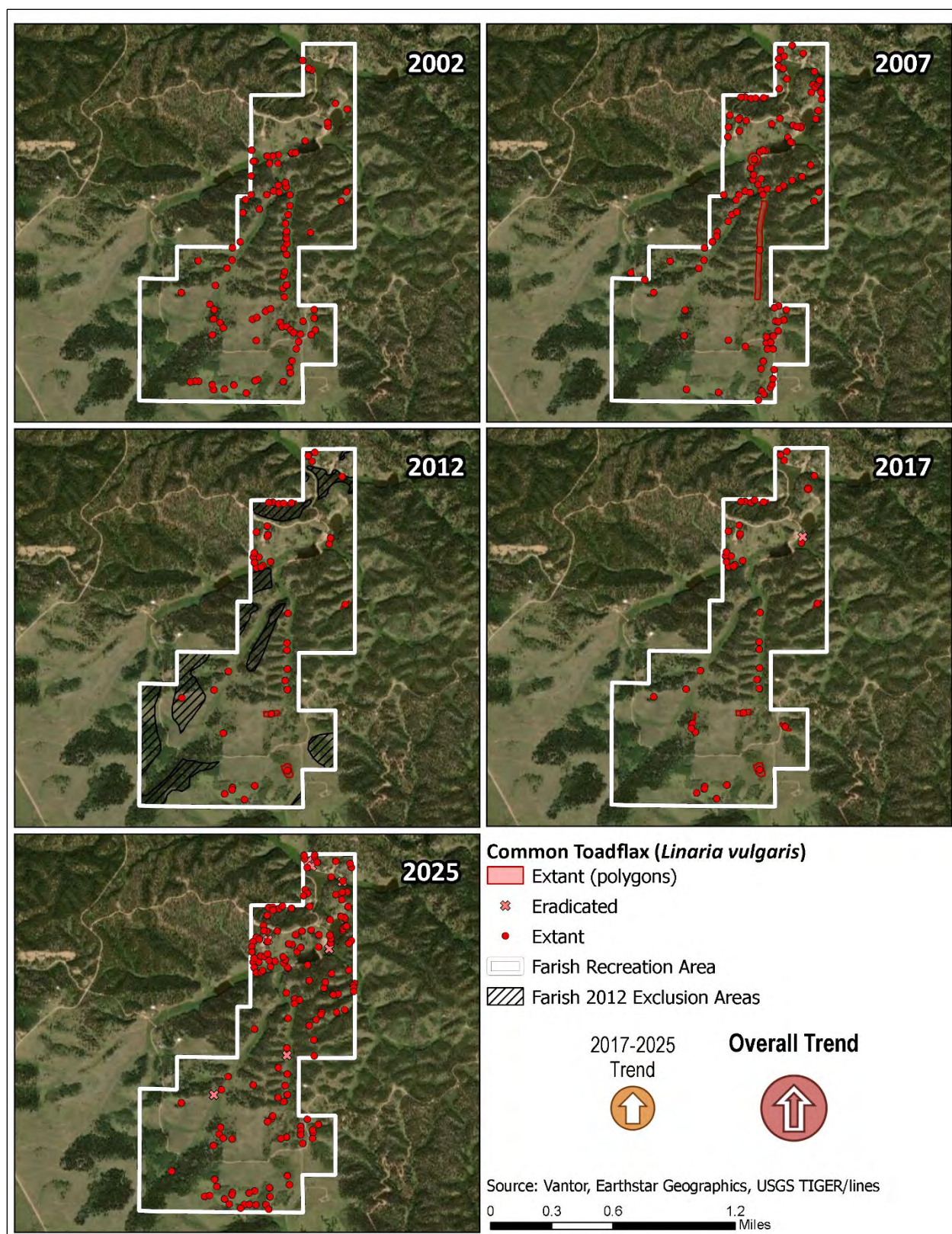
Figure 47. Ali Lamberson mapping toadflax and musk thistle at the Farish. A patch of the yellow toadflax can be seen on the left side of the image. Photo by Rob Monahan, 2025.

Farish Recreation Area 2025 Mapping Results

The mapping of yellow toadflax was more thorough in 2025 than in 2017 which accounts for some of the increase. Small dense patches were mapped in 2025 as well as large patches but individual plants were not mapped. Common toadflax remains the most ubiquitous noxious weed that occurs at the Farish. This species has increased according to all metrics from 2017 to 2025 (Table 45 and Map 48).

Table 45 All mapping of common toadflax at the Farish.

Year	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2002	---	---	---	---
2007	0.18	9,470	6	0
2012	6.01	18,179	32	0
2017	9.15	57,515	44	1
2025	25.16	720,375	147	7



Map 48. Distribution of common toadflax at the Farish in 2025.

Tatarian, Marrow's, and Showy Fly Honeysuckle (*Lonicera tatarica*, *Lonicera morrowii*, *Lonicera × bella*)

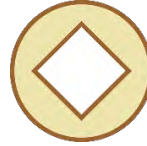
Change from 2024–2025:

Tatarian honeysuckle: Stable;

Morrow's honeysuckle: Unknown

Management Goals: Containment

State List: Not Listed in Colorado (Garden Escape)



- Commonly planted and escaping to disturbed sites.
- Seeds are spread widely by animals.
- At the AFA one population is growing with a rare plant species, American currant.
- Plants can sprout after treatments.
- Tatarian honeysuckle and Morrow's honeysuckle will hybridize giving rise to showy fly honeysuckle (*Lonicera × bella*) which has characteristics intermediate to its parents (Munger, 2005)
- Morrow's honeysuckle can be distinguished from Tatarian honeysuckle by examining the leaves, with Morrow's honeysuckle having hairy leaves especially the underside, and Tatarian honeysuckle having glabrous leaves above and below (Ackerfield, 2022; Munger, 2005)



Figure 48. *Lonicera tatarica* flowers close up (left) – Photo by Superior National Forest (CC BY 2.0) via Wikimedia Commons; *Lonicera tatarica* (right) – Photo by Juha Kallamäk (CC0) via Wikimedia Commons

2024–2025 Mapping Results

There are a total of 90 mapped locations of Tatarian honeysuckle, 80 of which were extant at the Academy a 129% increase from 2018 when there were just 35 extant locations (Table 46, Map 49, and Map 50). Better mapping in 2024 and 2025 may partly explain the increase in honeysuckle, but there has also likely been a real increase in the number of individuals at the base. A related species Marrow's honeysuckle (*Lonicera morrowii*), which is also introduced, was noticed to be growing alongside Tatarian honeysuckle at 7 sites in 2024. These species hybridize easily and are functionally the same from a management perspective. They require the same habitat and will have similar impacts. Marrow's honeysuckle is likely present at other Tatarian honeysuckle sites at the Academy but has gone unnoticed up to this point.

Table 46. Mapping of Tatarian honeysuckle at the Academy during the first pass

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002	---	---	---	---
2007	---	---	---	---
2008¹	0.15	20	1	0
2012¹	0.15	20	1	0
2013	0.18	28	5	0
2014	0.21	31	5	2
2015	0.40	48	9	1
2016	0.24	22	8	4
2017	0.24	8	6	3
2018	0.60	132	35	5
2020	0.81	113	35	9
2021	0.95	148	37	8
2022	---	---	---	---
2023	1.61	242	50	8
2024²	2.84	617	74	6
2025³	2.81	581	80	10

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Number of shoots at the original site documented in 2008 was previously reported to be 30 individuals, an estimate from a distance. This site was visited in 2014 for an actual count of 20.

² Noxious weeds were not mapped east of I-25 in 2024 due to ongoing construction. 9 Tatarian honeysuckle features which are east of I-25 were excluded from the 2024 mapping and analysis.

³ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

2025 Treatment

The resource management staff conduct all treatments for Tatarian honeysuckle at the Academy. In 2025, 70 sites were visited, and 504 individuals were found (Table 47, Map 50).

Table 47. Monitoring of Tatarian honeysuckle sites at the Academy in 2024.

Pass & Year	# Site Visits	# Shoots Mapped	# Manually Treated Shoots	# Sites with Plants	# Sites without Plants
2025 Pass 1	70	504	---	64	6
2025 Total	70	504	---	---	---
2021	14	83	---	---	---
2022	---	---	---	---	---
2023	48	216	---	---	---
2024	85	629	---	---	---
2025	70	504	---	---	---

Recommendations

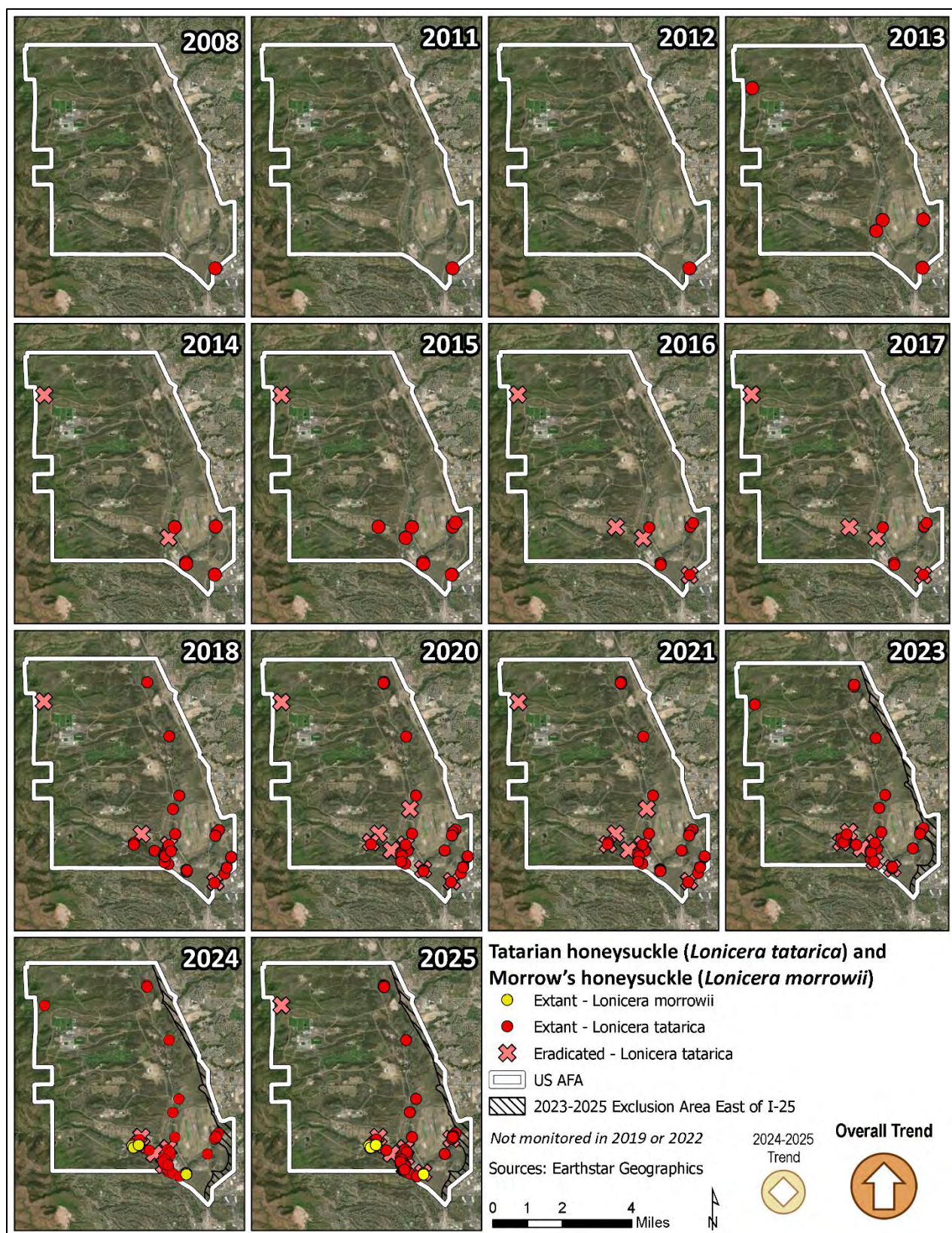
The management urgency for Tatarian honeysuckle is medium. Tatarian honeysuckle is a prolific seed producer but most of the plants found at the Academy are small trees or large shrubs and have been present for a number of years. Most of the increases are due to finding new occurrences of mature plants or sprouting individuals from known locations. When Tatarian honeysuckle is not flowering it is very easy to miss in surveys of dense vegetation. It does not appear to be highly invasive at the Academy. The Academy personnel have been conducting removal of Tatarian honeysuckle. Recommendations for Marrow's honeysuckle and showy fly honeysuckle are identical to that of Tatarian honeysuckle. The three closely related species can effectively be managed as if they were the same species.

- Continue to incidentally monitor known sites in between basewide monitoring activities.

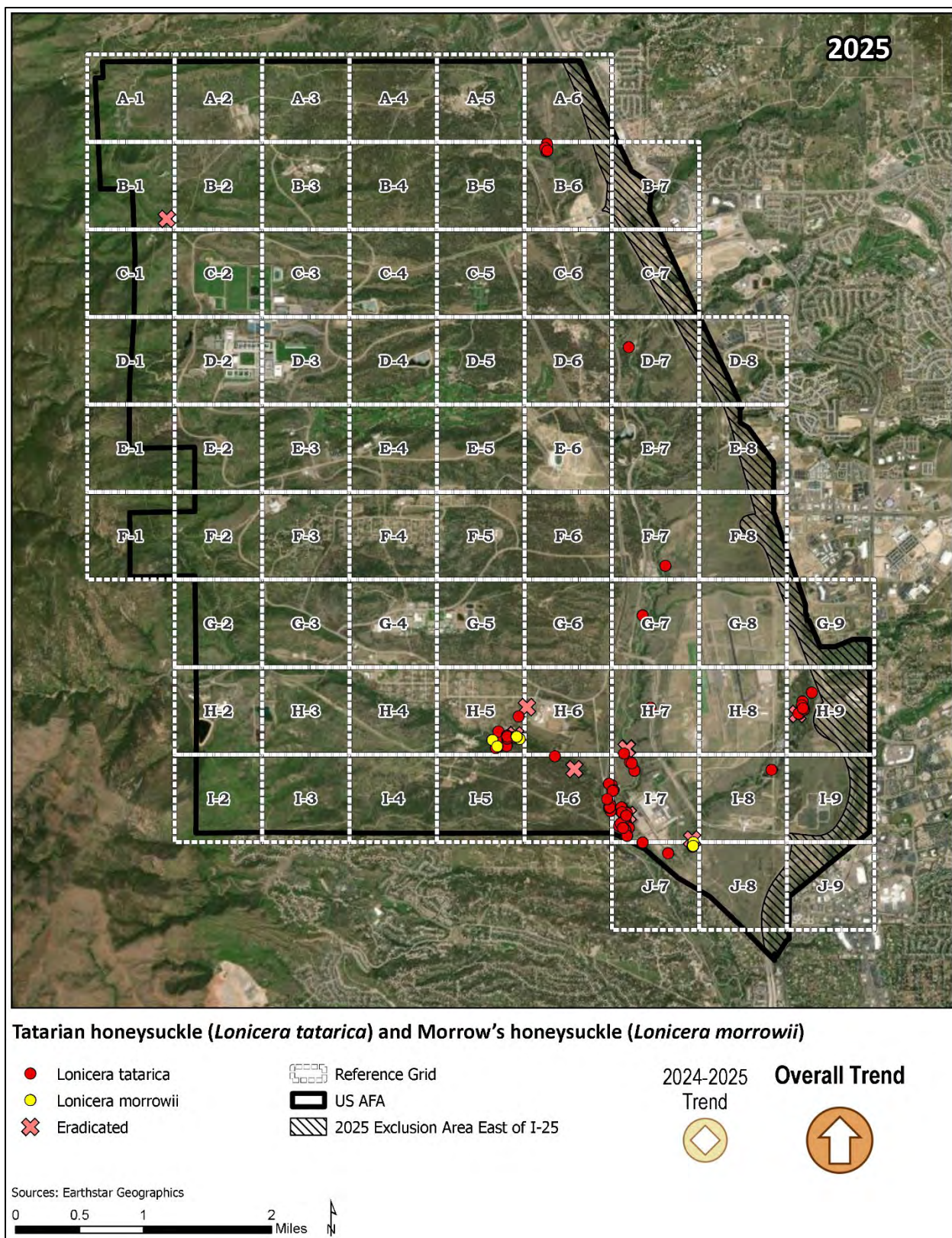
History of Sampling and Treatment:

- Tatarian honeysuckle was first discovered at the Academy in 2008 with American currant (*Ribes americanum*), a State rare plant species tracked by CNHP.
- Tatarian honeysuckle occupied 0.15 acres with approximately 30 individuals at one site in 2012.

- In 2013, four new locations were documented with eight individuals. The original site was not revisited but was assumed extant.
- In 2014, the original site documented in 2008 was visited for an actual count and found to have 20 individuals. The original number of 30 individuals was an estimate. This site is difficult to access due to dense growth and steep terrain.
- In 2015, there was an increase from 31 to 48 individuals and from 5 to 9 extant mapped features. Sprouting trees at treatment contributed to this increase.
- In 2016, all known sites were visited, and two new sites were added. At the site on the SE side of the AFA there were 20 individuals in 2014. There was a substantial decline at this site in 2016, with only one living individual and 19 standing dead trees, apparently of natural or man-made hydrological influences.
- In 2017, one site which had 13 individuals last year appears to be defoliated and accounts for a drop from 2016. If these trees do not re-sprout, it will represent a true decline.
- In 2018, the basewide mapping shows an increase from one individual in 2012 to 35 in 2018. Some of the trees are mature and those do not reflect an increase. Some increases are sprouts that occur as a result of treatments.
- In 2019, Tatarian honeysuckle was not monitored.
- In 2020, 27 sites were visited with 85 individuals at 80 extant sites. No sites were visited East of I-25 along Pine Creek which included eight features with 31 individuals mapped in 2018.
- In 2021, 14 sites were visited while monitoring other higher priority noxious weeds in the vicinity. One new location was mapped with three individuals.
- In 2022, no surveys or treatments were undertaken.
- In 2023, 47 sites were visited while monitoring other higher priority noxious weeds in the vicinity. Thirteen new locations were mapped this year containing 62 new individuals.
- In 2024, during basewide mapping at the Academy many new sites were mapped, and the related Marrow's honeysuckle (*Lonicera morrowii*) was found growing alongside Tatarian honeysuckle at seven sites.
- In 2025, 70 sites were visited while monitoring other higher priority noxious weeds in the vicinity.



Map 49. Distribution of Tatarian honeysuckle at the Academy between 2008 and 2025.



Map 50. Distribution of Tatarian honeysuckle at the Academy in 2025 with the reference grid.

Scotch Thistle (*Onopordum acanthium*)

Change from 2024–2025: Rapidly Increasing
Management Goals: Containment and suppression
State List: B



- Biennial with a taproot that grows to 30 cm. (Cavers 2011)
- Germination is in the fall.
- Rosettes form first year.
- Temperature and moisture content of soil are more important than nutrient content of soil for this species.
- Reproduction is only by seed (Cavers 2011)
- Drought resistant (Cavers 2011)
- Seed longevity is 7–40 years (Cavers 2011)



Figure 49. *Onopordum acanthium* found at the Academy in July 2024, first year basal rosette (left), flowering head (right) – Photos by Robert Monahan

2025 Mapping Results

Scotch thistle populations were stable at the Academy from 2021 to 2024 but have rapidly increased in 2025. Scotch thistle currently occupies an estimated 4.15 acres at the Academy and there are an estimated 6,509 shoots (Table 48, Map 51, Map 52, and Map 53). Some new sites were found this year which were a significant distance from known populations.

Table 48. Mapping of Scotch thistle at the Academy during the first pass.

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002¹	0.17	52	7	0
2005	0.42	137	12	0
2007	1.31	1,307	36	0
2008	1.14	144	27	17
2009	3.47	1,710	50	34
2010	0.66	669	61	30
2011	0.64	293	39	56
2012	0.30	889	66	73
2013	?	970	48	85
2014	0.84	1,224	74	81
2015	1.60	1,629	157	76
2016	1.13	1,331	128	127
2017	1.35	791	120	155
2018	2.04	1,914	275	143
2019	2.35	3,137	290	135
2020	3.59	3,364	268	163
2021	3.81	3,859	276	172
2022	---	---	---	---
2023	3.04	3,582	225	241
2024²	3.64	2,188	214	315
2025³	4.15	6,509	264	306

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹2002 values are from field notes, this species was not adequately mapped in GIS.

²One previously extant (2018–2021) Scotch thistle feature east of I-25 was excluded from the 2024 mapping and analysis. This feature was not monitored from 2022 to 2024.

³Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

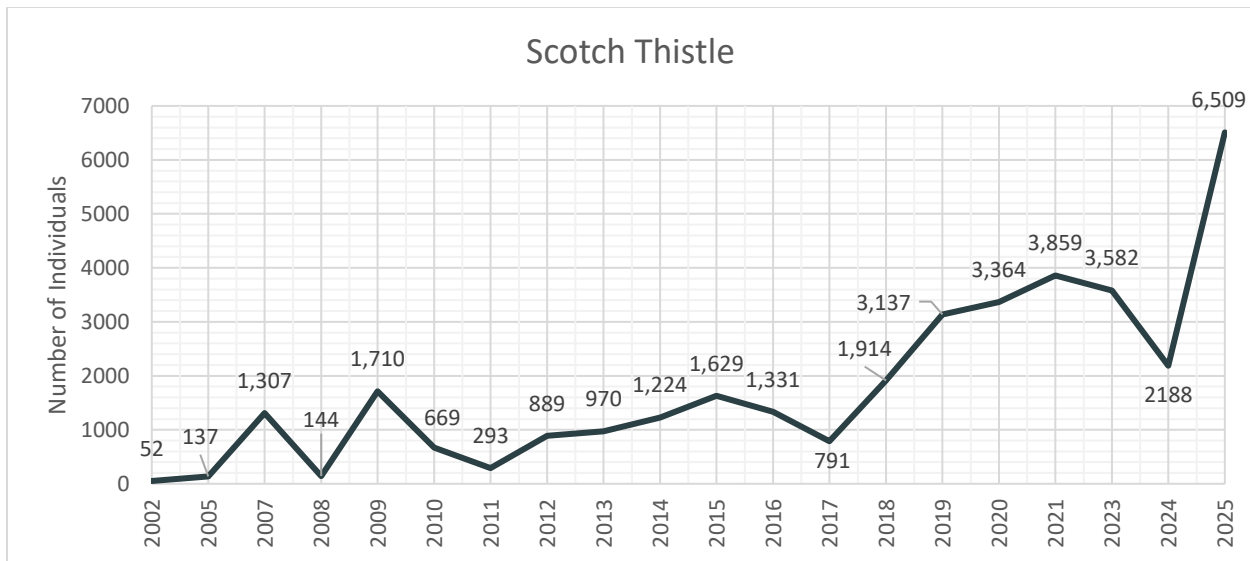


Figure 50. Number of Scotch thistle individuals mapped during the first pass, 2002-2025.

2025 Treatment

The cover of Scotch thistle at the Academy is the highest of all the targeted weeds for manual treatments at just over four acres. The area with the largest number of individuals is east of the Academy track and some of the larger populations occurred north of the small drainage east of the track field. In 2025, a total of 460 site visits were made and 3,106 individuals were treated (Table 49). Some sites contained just a few individuals while others contained up to several hundred. Large plants that had already begun to drop their seeds (dead standing) were not removed. The removal of plants could also stimulate the seed bank by opening and disturbing the soil.

Table 49. Monitoring and treatment of Scotch thistle sites at the Academy in 2025.

Pass & Year	# Site Visits	# Shoots Mapped	# Manually Treated Shoots	# Sites with Plants	# Sites without Plants
2025 Pass 1	453	5,994	3,101	207	24s6
2025 Pass 2	7	11	5	4	3
2025 Total	460	6,005	3,106	---	---
2021	623	7,134	6,662	---	---
2022	---	---	---	---	---
2023¹	752	4,599	4,599	---	---
2024¹	562	2,817	1,868	---	---
2025¹	460	6,005	3,106	---	---

¹ One previously extant (2018–2021) Scotch thistle feature east of I-25 was excluded from the 2024–2025 mapping and analysis. This feature was not monitored from 2022 to 2025.

In 2025, eight areas of the Academy were targeted for manual treatments. These include a population east of the Academy track (Figure 51, frame A). This first population (Figure 51, frame A) is composed of two subpopulations, one is contained within about 400 ft east of the track and received complete treatment of all Scotch thistle found. The second subpopulation is in the field farther east of the track and in 2025 only the edges of this subpopulation were treated due to the large number of plants present. The remaining seven areas targeted for manual treatments include the population south of the Barry Goldwater Visitor Center (Figure 51, frame B), a growing population north of Davis Air Field (Figure 51, frame C, and Figure 51), a population surrounding the Dean's residence (Figure 51, frame D), two small population east of the High School (Figure 51, frame E & F), three small populations along Kettle Creek (Figure 51, frame G), and a population just south of the solar arrays near I-25 (Figure 51 frame H). Table 50 shows the comparison of treatments since 2019 for each of these eight areas.

Table 50. Number of Scotch thistle individuals treated at populations (A-H) at the Academy in 2025.

Frame	Population	2019	2020	2021	2022	2023	2024	2025
A	Track (400 ft)	47	91	376	---	159	66	377
A	Track (All)	---	---	---	---	1,049	737	1,510
B	Visitor Center	---	---	---	---	5	14	43
C	North of Airfield	---	---	---	---	---	107	325
D	Dean's Residence	---	---	4,184	---	220	117	690
E	High School	91	469	126	---	20	52	89
F	Pine Drive	131	31	22	---	25	30	8
G	Kettle Creek	---	---	---	---	---	690	451
H	Solar Array	139	144	180	---	22	66	100

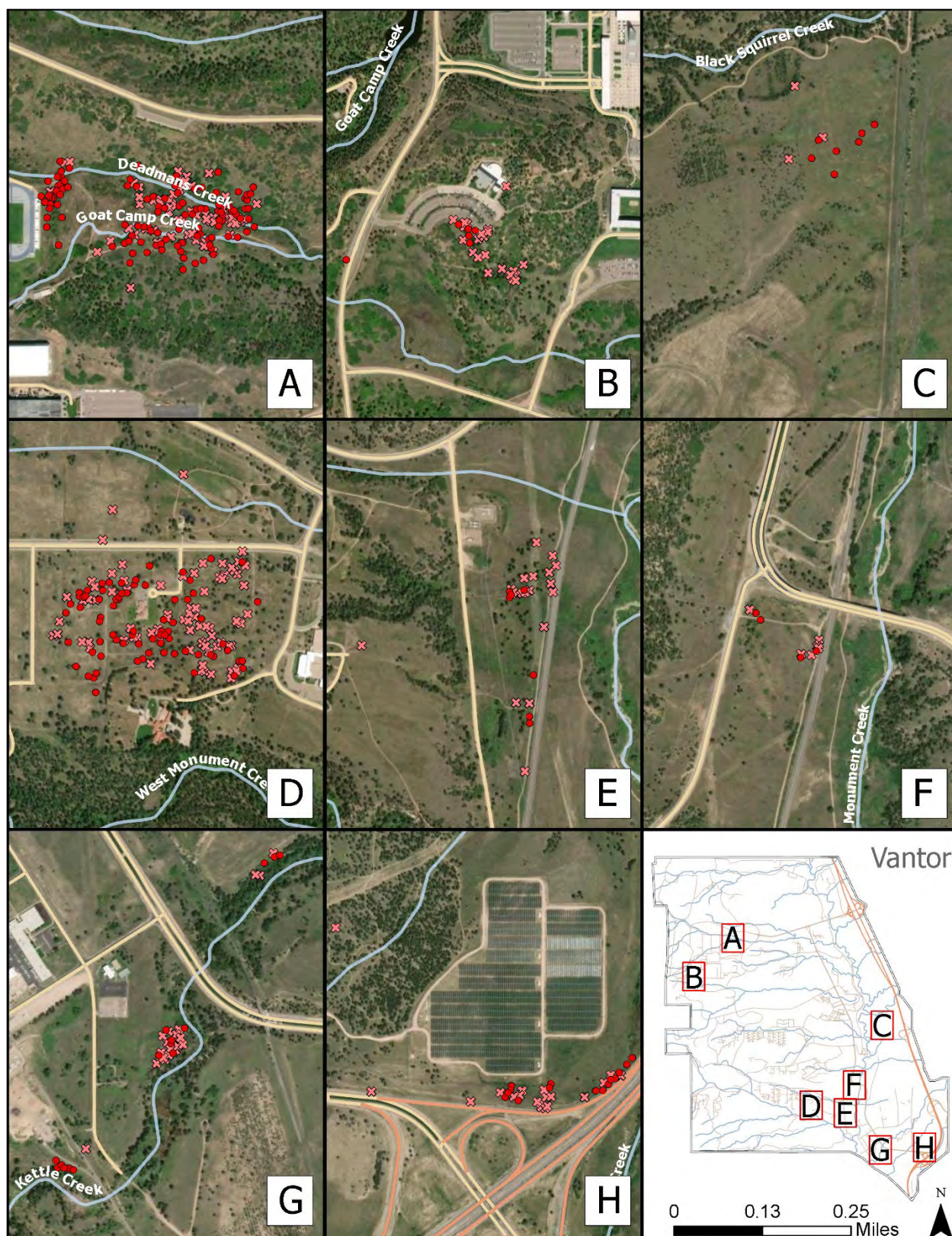


Figure 51. Populations of Scotch thistle across the Academy (frames A-H) in 2025. Extant Scotch thistle sites are represented by a red dot and eradicated sites are represented by a "x."

Recommendations

The management urgency for Scotch thistle is high since it is a biennial and reproduces only by seed. The cover at the Academy has reached a point where basewide eradication is unlikely, therefore containment and suppression should be the goals of treatment.

Recommendations for treating Scotch thistle:

- Continue spring surveys to remove as many Scotch thistle rosettes as possible.
- Revisit as many sites as possible throughout the growing season to remove plants before seeds set and before the plants get to a large size.
- Focus manual treatment efforts on small populations where eradication is feasible and the edges of larger populations where containment is feasible.
- Use herbicide application on populations where manual treatments are not likely to be effective and the plants species composition is mostly introduced species.
- An area where herbicide application should be considered is the area east of the Academy track (Figure 51, frame A and Map 53, Grid C-3). This area has high cover of non-native species, especially smooth brome (*Bromus inermis*) and knapweeds (*Centaurea* spp.), and the number of individuals is unlikely to be controlled with the current regime of manual treatments.

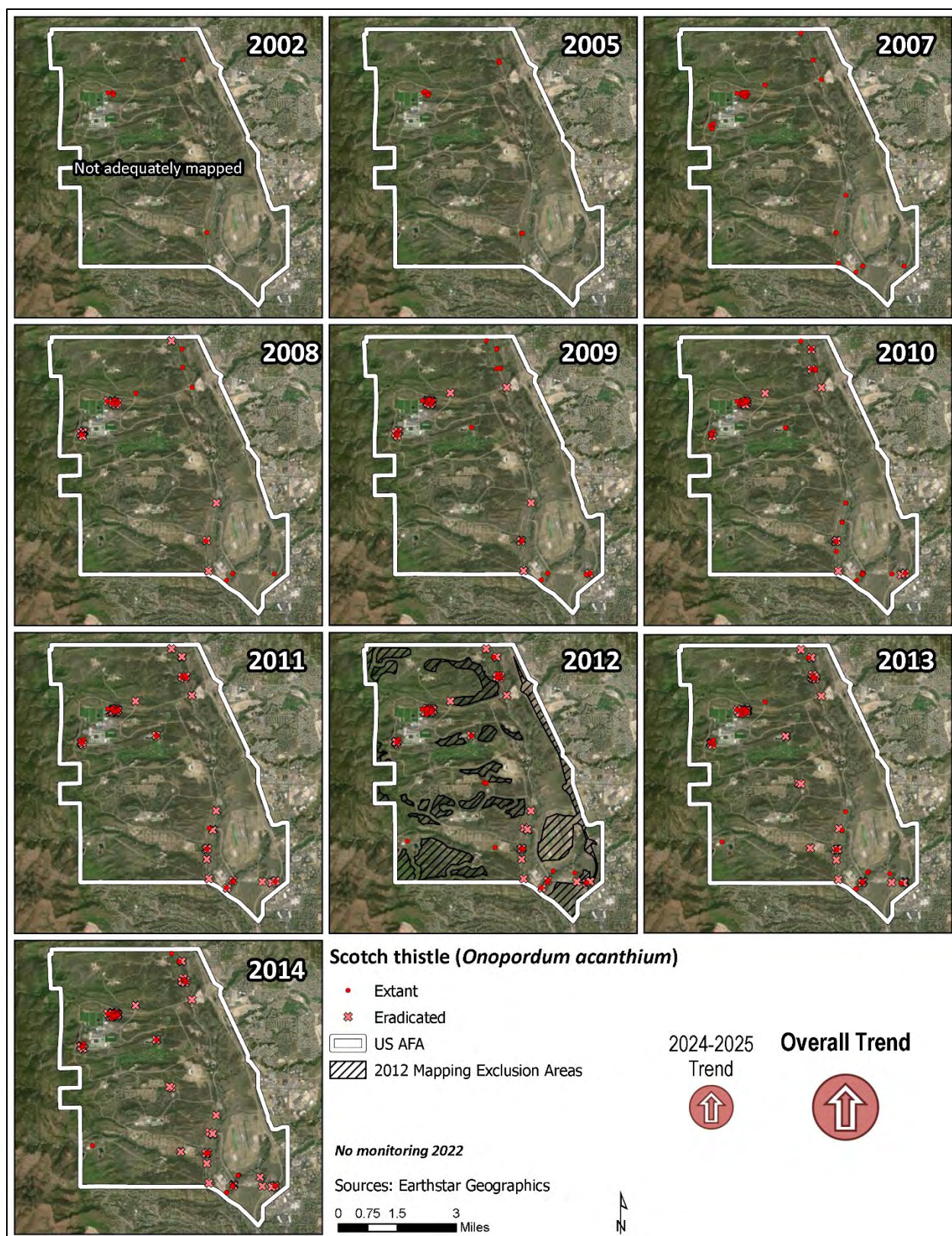
Seeds are the only way this species reproduces, so preventing plants from going to seed and removing sprouts throughout the growing season should yield decreases. A single plant can result in hundreds of new plants the following season. For example, in 2018, seven weed points with a total of 51 individuals (untreated) had 300 plants the following year. The key is removal of rosettes throughout the growing season as they sprout, with the goal of having no seed production. The smaller the rosettes are when they are treated the less soil disturbance. Bolted individuals are the most difficult to treat effectively and viable seeds can still be produced. Seed longevity is noted as 7– 20 years.

History of Sampling and Treatment:

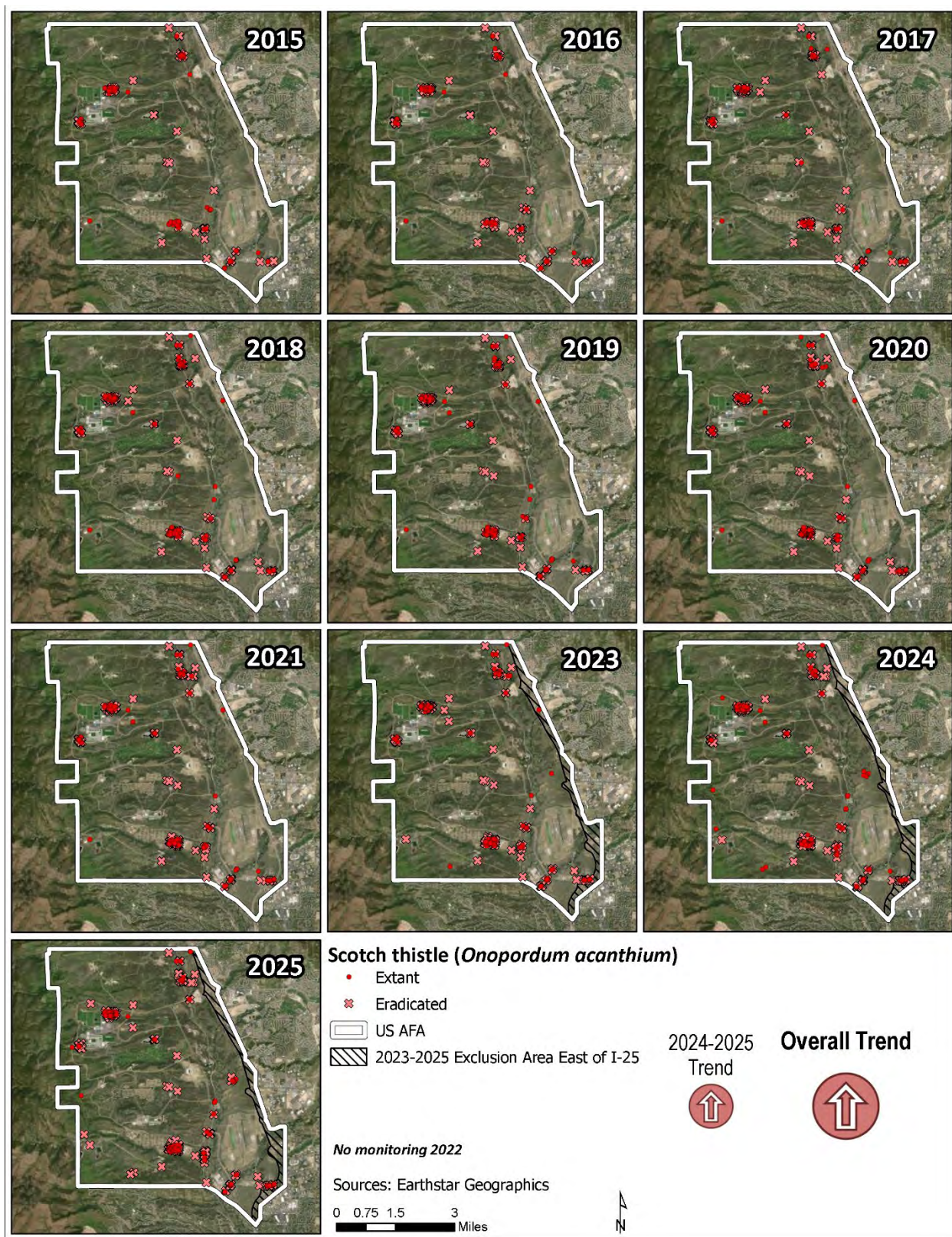
- The occupied areas, number of individuals and the occupied acres at the Academy have fluctuated since Scotch thistle was first monitored in 2002.
- The population of Scotch thistle peaked in 2007 and 2009 with a decline in 2010.
- In 2014 and 2015 it was evident that many treated areas had sprouting individuals. Bare ground left behind in both successfully controlled and unsuccessfully controlled sites provided more habitat for noxious weeds.
- In 2015, the number of extant features was higher due to the addition of new survey areas that were not part of the previous year's survey. The overall trend since 2002 is increasing.
- In 2016, there were fewer extant sites compared to 2015 because the populations added in 2015 located west of Pine Valley High School were treated. However, the number of extant features is still the third highest recorded since monitoring began in 2002.
- In 2017, there were 120 extant sites (similar to the 128 in 2016) but fewer individuals were observed.
- In 2018, the basewide mapping showed 275 extant sites with almost 2,000 individuals observed.
- In 2019, Scotch thistle continues to increase with 290 extant features and 3,137 individuals mapped.
- In 2020, there were 296 sites visited with half of the sites eradicated. Scotch thistle continues to increase across the base with new locations in newly disturbed areas.
- In 2021, Scotch thistle increased in numbers of individuals, cover and number of sites. Higher spring-summer precipitation and other conditions resulted in numerous sprouts throughout the season.
- In 2022, no surveys or treatments were undertaken.
- In 2023, there were 466 sites visited and 4,599 individuals were treated. There was a substantial decrease in the size of the population surrounding the Dean's residence even though the total number of individuals was stable at the Academy as a whole.
- In 2024, during basewide mapping at the Academy nearly all Scotch thistle sites were visited at least once in the season. The population around the

Dean's residence remains under control, while some populations such as the one east of the Academy track has increased. The population north of Davis Airfield has become firmly established and has grown from a single site to seven.

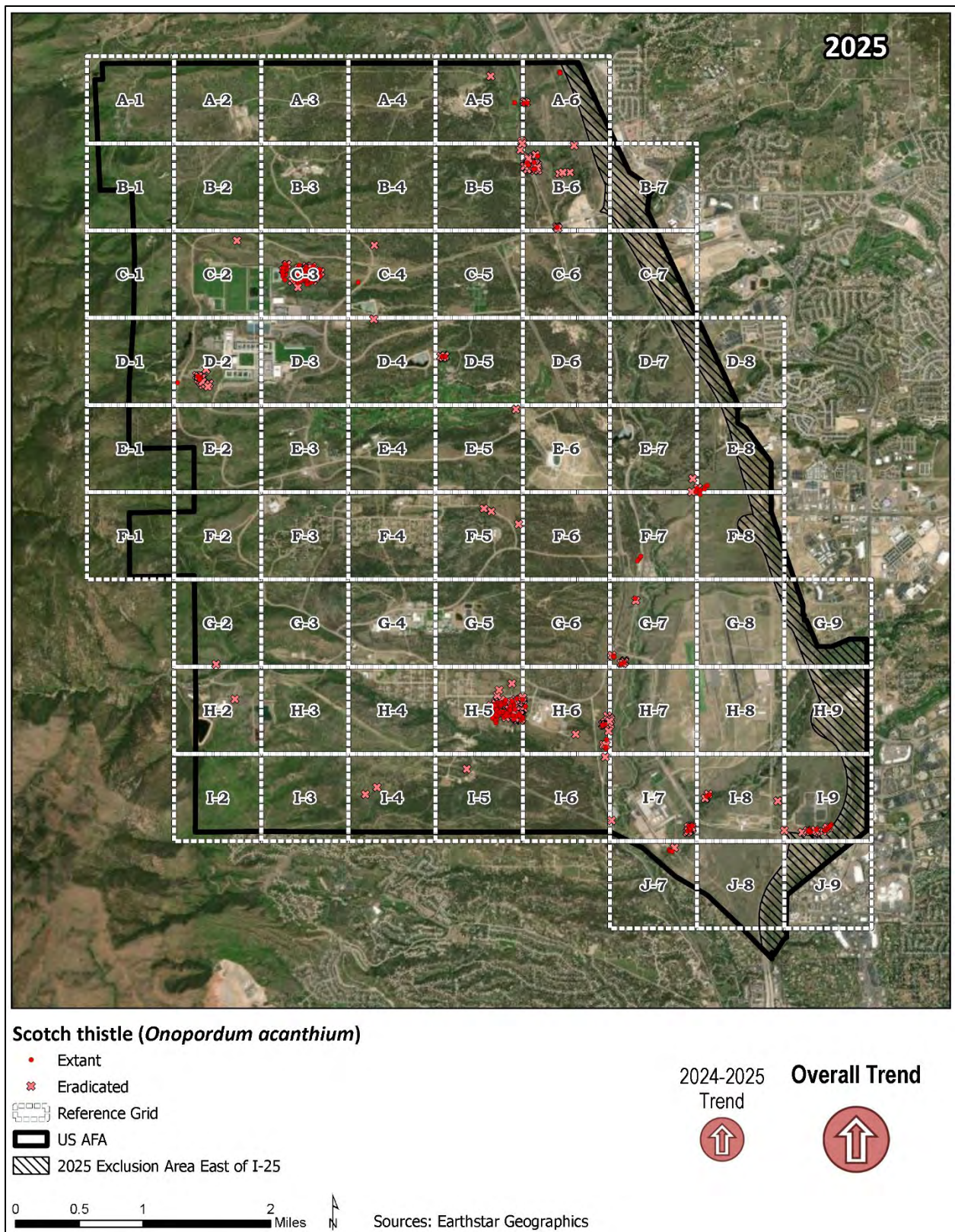
- In 2025, there were large increases in the number of individuals found at many of the populations across the Academy. 6,005 individuals were mapped and 3,106 were treated at targeted high priority populations.



Map 51. Distribution of Scotch thistle at the Academy between 2002 and 2014.



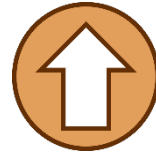
Map 52. Distribution of Scotch thistle at the Academy between 2015 and 2025.



Map 53. Distribution of Scotch thistle at the Academy in 2025 with the reference grid.

Russian Knapweed (*Rhaponticum repens*)

Change from 2024–2025: Increasing
Management Goals: Eradication
State List: B



- Reproduces by spreading by lateral roots and from seeds (Jacobs and Denny, 2006)
- Root buds are active in winter and spring.
- Roots of newly established plants can expand rapidly (Beck, 2013c; Jacobs and Denny, 2006)
- Emerges early spring, bolts May – June, flowers into fall.
- Rapid Response is still a viable treatment at the AFA.
- Seed longevity 2–3 years (Jacobs and Denny, 2006)



Figure 52. *Rhaponticum repens* found at the Air Force Academy in May 2024, note the papery non-spiny phyllaries (left) and lobed leaves (right) – Photos by Robert Monahan

2025 Mapping Results

Russian knapweed has had a small increase from 2024 when 78 individuals were found, in 2025 there were 114 individuals mapped (Table 51). For a period of five years from 2013 to 2017, all known sites were eradicated (Table 51). The seed longevity of this species is thought to be five years.

Table 51. Mapping of Russian knapweed at the Academy during the first pass.

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002	---	---	---	---
2004	?	?	3	0
2005	< 0.01	54	2	1
2007	0.03	200	2	2
2008	0.025	157	2	2
2009	?	?	2	2
2010	0	0	0	4
2011	0	0	0	4
2012	0.05	543	10	2
2013	0	0	0	12
2014	0	0	0	12
2015	0	0	0	12
2016	0	0	0	12
2017	0	0	0	12
2018	0.02	44	3	11
2019	0.18	94	3	11
2020	0.18	183	2	12
2021	0.18	152	2	11
2022	---	---	---	---
2023	0.20	188	4	11
2024 ¹	0.02	78	4	10
2025 ^{1,2}	0.18	114	3	11

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Two features east of I-25 were not included in the 2024 or 2025 mapping and analysis. These features were eradicated from 2013 to 2021 and have not been monitored from 2022 to 2025.

² Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.



Figure 53. Number of Russian knapweed individuals mapped during the first pass, 2002-2024.

2025 Treatment

All sites except those east of I-25 were visited in 2025 at least once. There was a total of 114 individuals treated during the first site visit (Pass 1) at three extant sites (Map 56). Russian knapweed is known to sprout throughout the growing season from the deep root buds, so a second and third pass was conducted at the previously extant sites. A total of 3 shoots were removed during the second pass (Table 52).

All plants were treated by severing the root crowns 4-6 inches below the soil surface or removing entire plants, bagging all cut plants, and disposing of them in off-site dumpsters.

This treatment method combined with multiple follow-up site visits to remove sprouts throughout the growing season have been effective at weakening the underground root system and ultimately preventing seed production.

Table 52. Monitoring and treatment of Russian knapweed sites at the Academy in 2024.

Pass & Year	# Site Visits	# Shoots Mapped	# Manually Treated Shoots	# Sites with Plants	# Sites without Plants
2025 Pass 1	14	114	114	3	11
2025 Pass 2	9	3	3	1	8
2025 Total	23	117	117	---	---
2019	14	116	116	---	---
2020	15	293	293	---	---
2021	15	254	254	---	---
2022	---	---	---	---	---
2023	22	226	226	---	---
2024	26	85	85	---	---
2025	23	117	117	---	---

Recommendations

The management urgency continues to be high for Russian knapweed at the Academy. This species has very low cover but has the potential to expand rapidly if not controlled due to extensive underground parts with root buds that sprout throughout the growing season.

Recommendations for Russian knapweed:

- Visit all sites in early summer to remove any sprouts to prevent seed set later in the season.
- Follow-up visits in middle and late summer to any sites with Russian knapweed present and all of the sites that were extant in 2025.

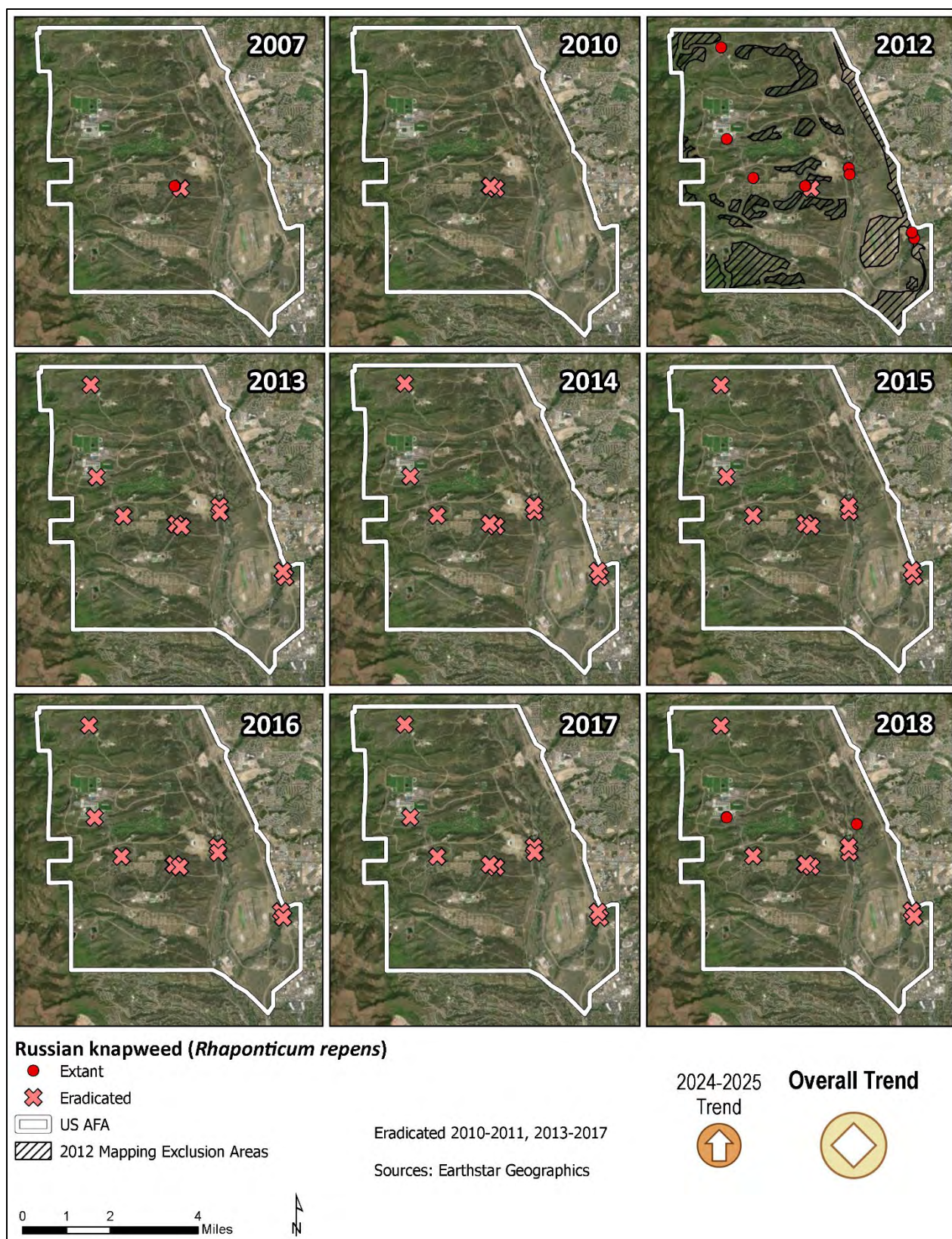
- Continue to remove all sprouts when found and as much of the root as possible while minimizing soil disturbance.

Russian knapweed is found to be very susceptible to fall-applied herbicides (Beck, 2008c) which are not currently recommended. Biological control is not yet available for Russian knapweed and currently the populations are not large enough to consider an application. As long as the numbers continue to decrease at the few active sites, manual removal is recommended at least three times during the growing season. Seed longevity is estimated to be five years; follow-up visits should be maintained for at least five years from the last extant occurrence. Encouraging native grasses to grow in areas where Russian knapweed has been treated is a recommended cultural control (Beck, 2008c; Jacobs and Denny, 2006).

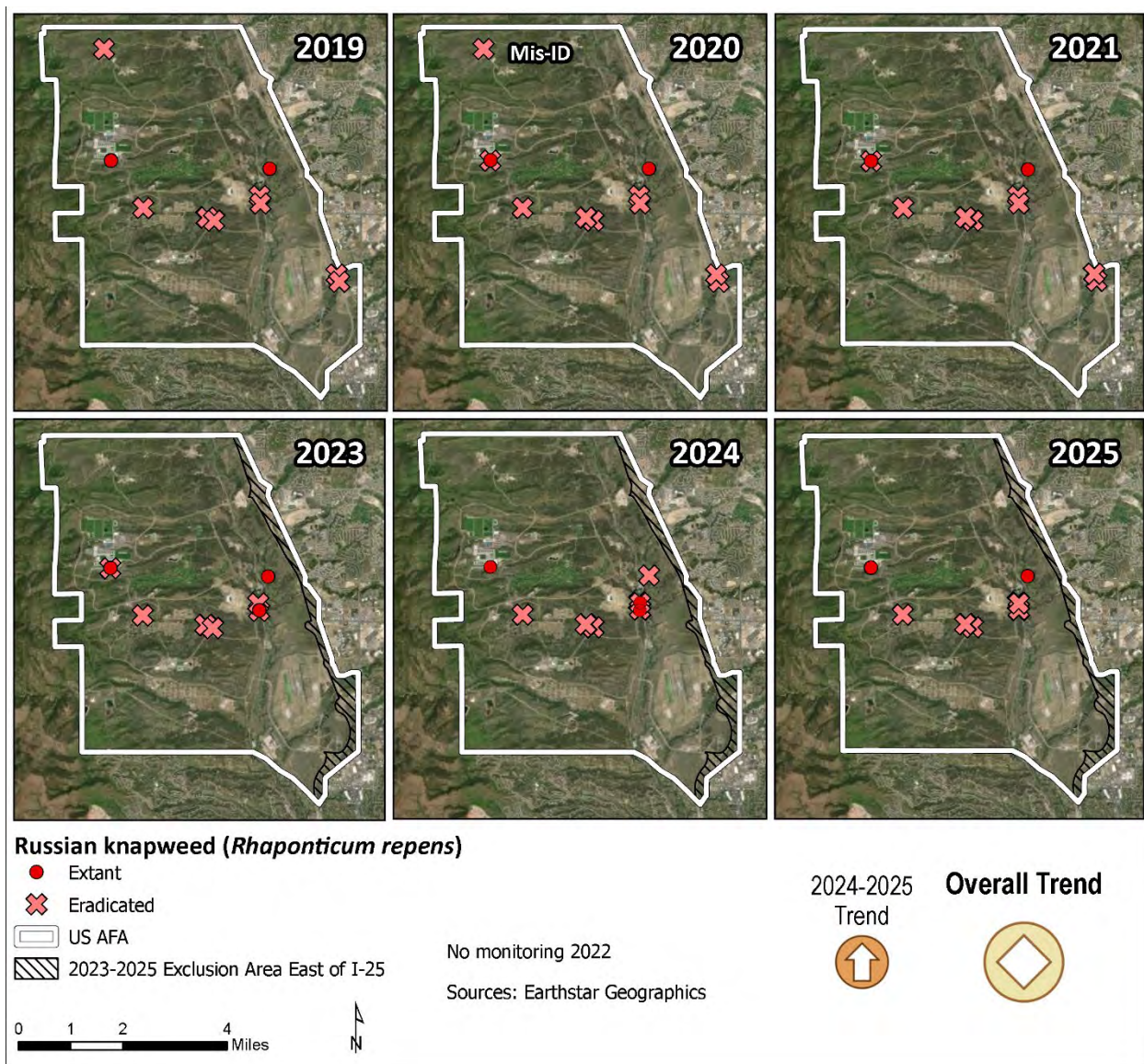
History of Sampling and Treatments:

- The first appearance of Russian knapweed was in 2004, and by 2007, there were two extant occurrences and two eradicated occurrences, all near Douglass Way.
- By 2009, two occurrences were eradicated and two were sprayed that year (Rondeau and Lavender 2012). None of these infestations have re-established in subsequent years.
- In 2005, herbicide treatment was applied to part of the Skills Development Center and Douglass Way occurrences and the Skills Development Center was treated again in 2009. Specific details about the first two locations can be found in Anderson and Lavender (2008b).
- In 2012, when 10 new locations were mapped, Russian knapweed occupied 0.05 acres with 543 shoots. This represented a 172% increase in number of shoots and a 400% increase in number of extant features since 2007.
- In 2013, all extant locations were treated (0.05 acres), and no live plants were observed in 2013 or in 2014. In 2014, a rosette was tentatively identified as Russian knapweed and was later identified as spotted knapweed.
- In 2015, no new populations were identified, and no extant features were observed at eleven of the twelve known sites.
- In 2016, all twelve known sites were visited, and no Russian knapweed plants were found.
- In 2017, seven of the twelve known sites were visited, and no Russian knapweed plants were found.

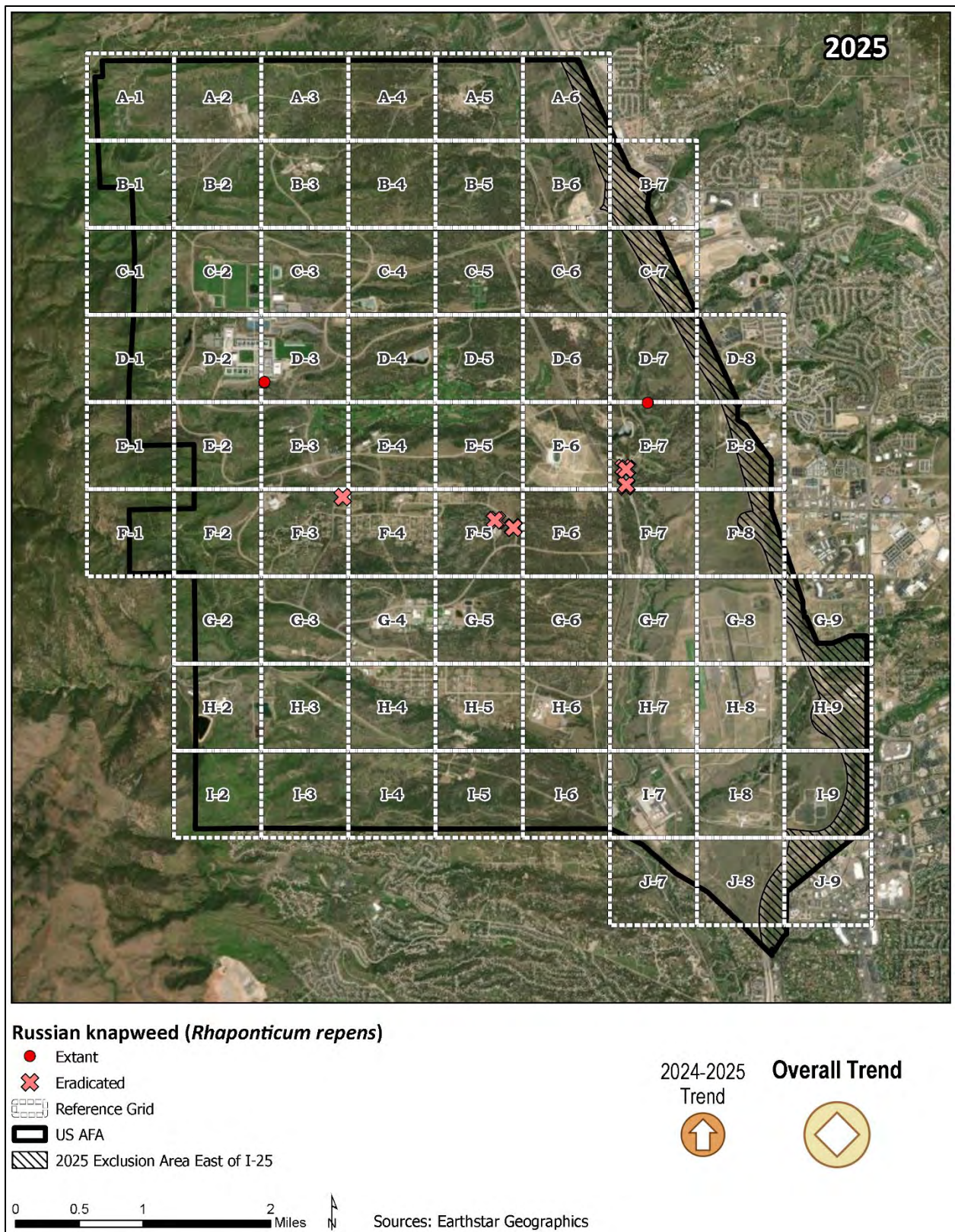
- In 2018, fourteen sites were visited and three had Russian knapweed plants. One of the three sites represents a new location; it was found on the east side of the Academy with 35 individuals.
- In 2019, eleven out of fourteen total sites were visited in the summer and three sites were extant. The three sites east of I-25 were not visited. In late summer, the three extant sites were re-visited, and two sites had sprouts that were removed. A total of 116 individuals were removed and no plants went to seed.
- In 2020, 11 sites were visited, and two sites contained Russian knapweed plants. Three sites east of I-25 were not visited. A total of 293 individuals were removed during the summer. No plants went to seed in 2020.
- In 2021, 11 sites were visited (west of I-25) and two sites contained Russian knapweed plants. A total of 254 individuals were manually treated. Plants sprouted throughout the growing season at the site northeast of the Natural Resources Building.
- In 2022, no surveys or treatments were undertaken.
- In 2023, there were twelve sites visited, four of which were extant. A total of 226 plants were treated manually.
- In 2024, during basewide mapping at the Academy all sites were visited. Extant sites were treated twice, and there was an overall decrease in the number of Russian knapweed found.
- In 2025, all fourteen known sites were visited, and 117 individuals were treated.



Map 54. Distribution of Russian knapweed at the Academy between 2007 and 2018.



Map 55. Distribution of Russian knapweed at the Academy between 2019 and 2025.



Map 56. Distribution of Russian knapweed at the Academy in 2025 with the reference grid.

Bouncingbet (*Saponaria officinalis*)

Change from 2024–2025: Decreasing
Management Goals: Eradication
State List: B



- Perennial
- Self-fertile
- Reproduction from seeds and by rhizomes.
- Colony former
- Blooms summer-fall
- Seed longevity is unknown (Colorado Department of Agriculture, 2019).



Figure 54. *Saponaria officinalis* found at the Air Force Academy in August 2024 – Photos by Robert Monahan

2025 Mapping Results

In 2025, bouncingbet populations have decreased from an estimated 4,433 individuals across 38 features in 2024 to 2,535 individuals across 40 features in 2025 (Table 53, Map 57, and Map 58).

Table 53. Mapping of bouncingbet at the Academy during the first visit.

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002	?	?	1	0
2007	---	---	---	---
2012	---	---	---	---
2013	0.50	42,092	8	0
2014	0.14	42	2	6
2015	0.09	608	8	5
2016	0.05	535	8	6
2017	0.05	401	6	8
2018	0.17	4,585	26	8
2019	0.24	4,063	29	8
2020	0.20	2,337	24	14
2021	0.26	2,236	31	11
2022	---	---	---	---
2023	0.60	3,455	41	12
2024	0.66	4,433	38	22
2025 ¹	0.39	2,535	40	20

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹ Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

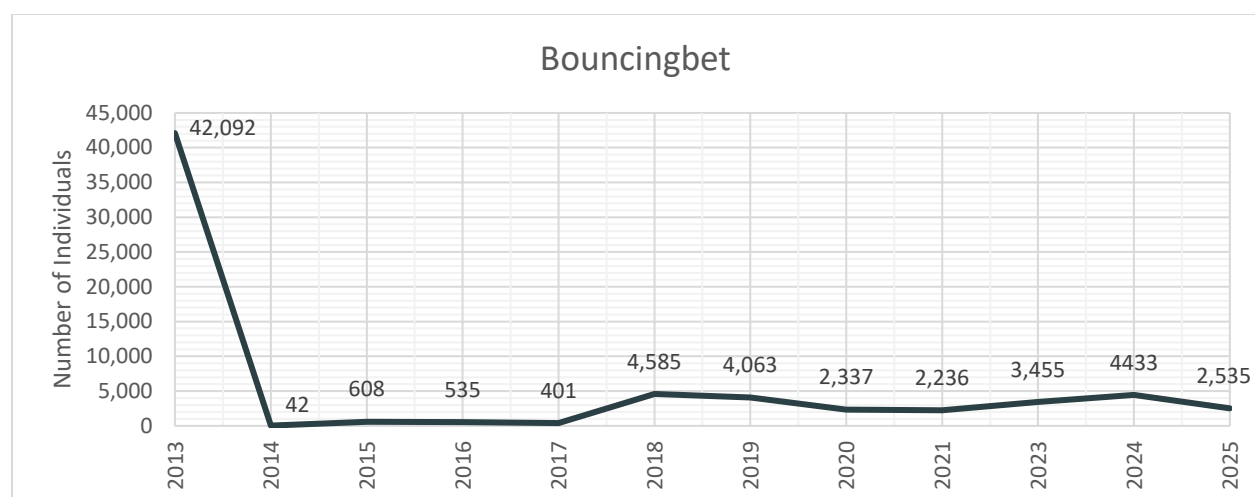


Figure 55. Number of bouncingbet individuals mapped during the first visit from 2013 to 2025.

2025 Treatment

In 2025, 48 mapped bouncingbet features were visited for monitoring and treatment (Map 58). Of the 2,395 individuals encountered in 2025, 570 were treated by CNHP staff. The untreated plants had already been grazed by ungulates which preferentially eat the flowers, or the untreated plants were not flowering (Table 54).

Table 54. Monitoring and treatment of bouncingbet sites at the Academy in 2025.

Pass & Year	# Site Visits	# Shoots Mapped	# Manually Treated Shoots	# Sites with Plants	# Sites without Plants
2025 Pass 1	48	2,294	485	35	13
2025 Pass 2	5	101	85	2	3
2025 Total	53	2,395	570	---	---
2021	29	898	898	---	---
2022	---	---	---	---	---
2023	65	3,440	3,440	---	---
2024	62	4,433	711	---	---
2025	53	2,395	570	---	---

Recommendations

Management urgency for bouncingbet is moderate because the occupied acres is under a half-acre, so eradication may still be feasible. The deep and extensive root system makes this species particularly resistant to eradication efforts, but this species is being effectively contained and suppressed under the current management regime.

Recommendations for bouncingbet:

- Continue to monitor all known sites.
- Protect native vegetation in the vicinity of the plants.
- Remove reproductive parts to prevent seed production.

Wildlife continues to graze the flower tops, which was first observed in 2016. Ungulates appear to preferentially graze the flowers of bouncingbet which are found in open areas with short herbaceous vegetation and avoid grazing individuals growing in areas with high shrub cover.

While herbicides appeared to be suppressing bouncingbet for a few years, many areas re-sprout due to the deep root system of this perennial species. Cheatgrass (List C) and smooth brome (a rhizomatous non-native grass) are common in many areas with bouncingbet. This needs to be considered when

treating this species. Annual precipitation, seed bank, and soil disturbances are contributing factors that may influence populations of bouncingbet.

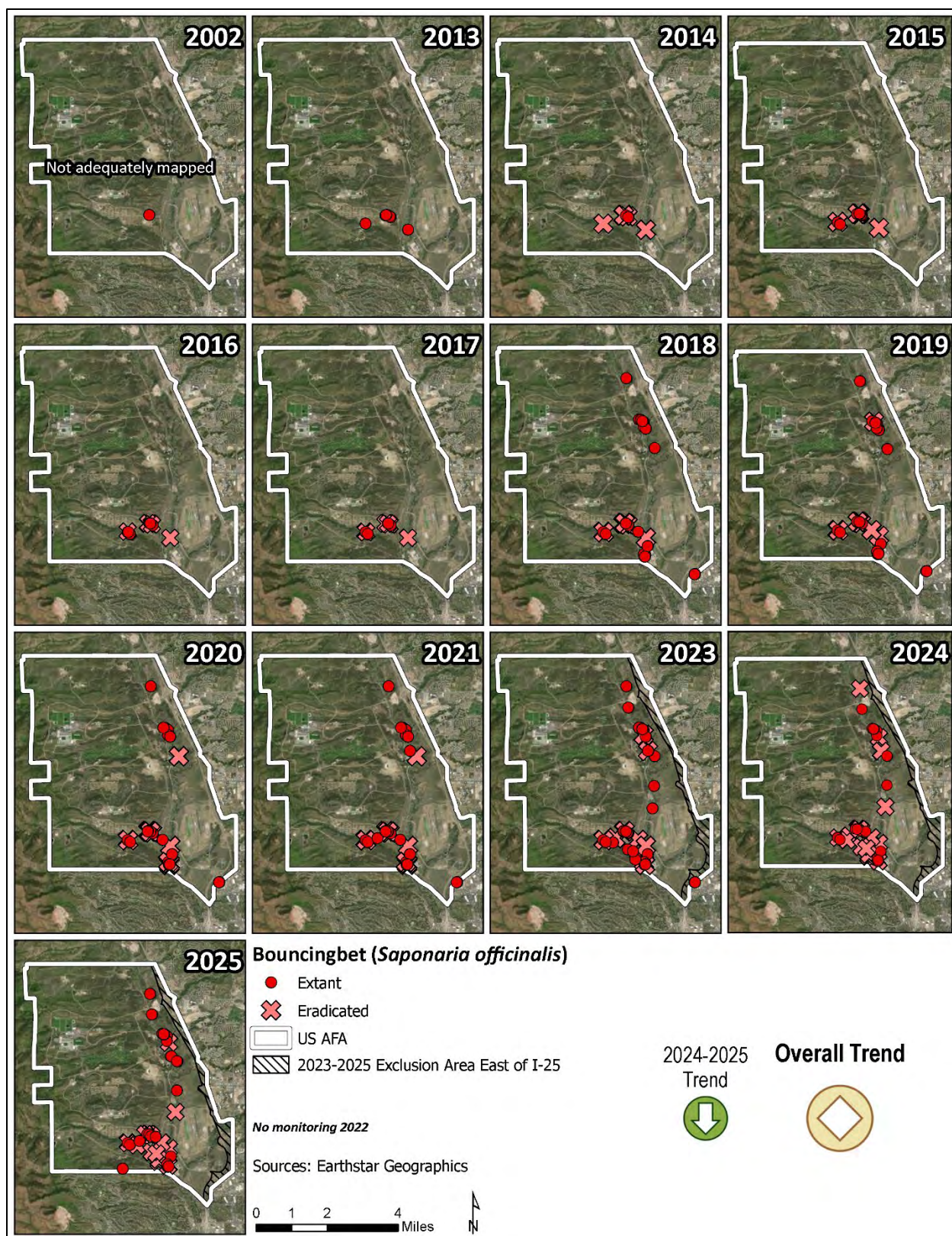
Bouncingbet also occurs in dense vegetation along the floodplains of Kettle and Monument Creeks. The dense growth and steep terrain are both obstacles to treatments. Most treatments result in vegetative growth from the deep root system (Colorado Department of Agriculture, 2019). There are no recommendations for herbicide or mechanical treatments alone. In addition, there are no herbicides recommended for treating bouncingbet in wildlands, only recommendations for rangelands and pastures (Colorado Department of Agriculture, 2019). Leaving as much native vegetation as possible is likely the best defense from keeping bouncingbet from spreading. Treatments that leave open bare soils are not recommended.

History of Sampling and Treatment:

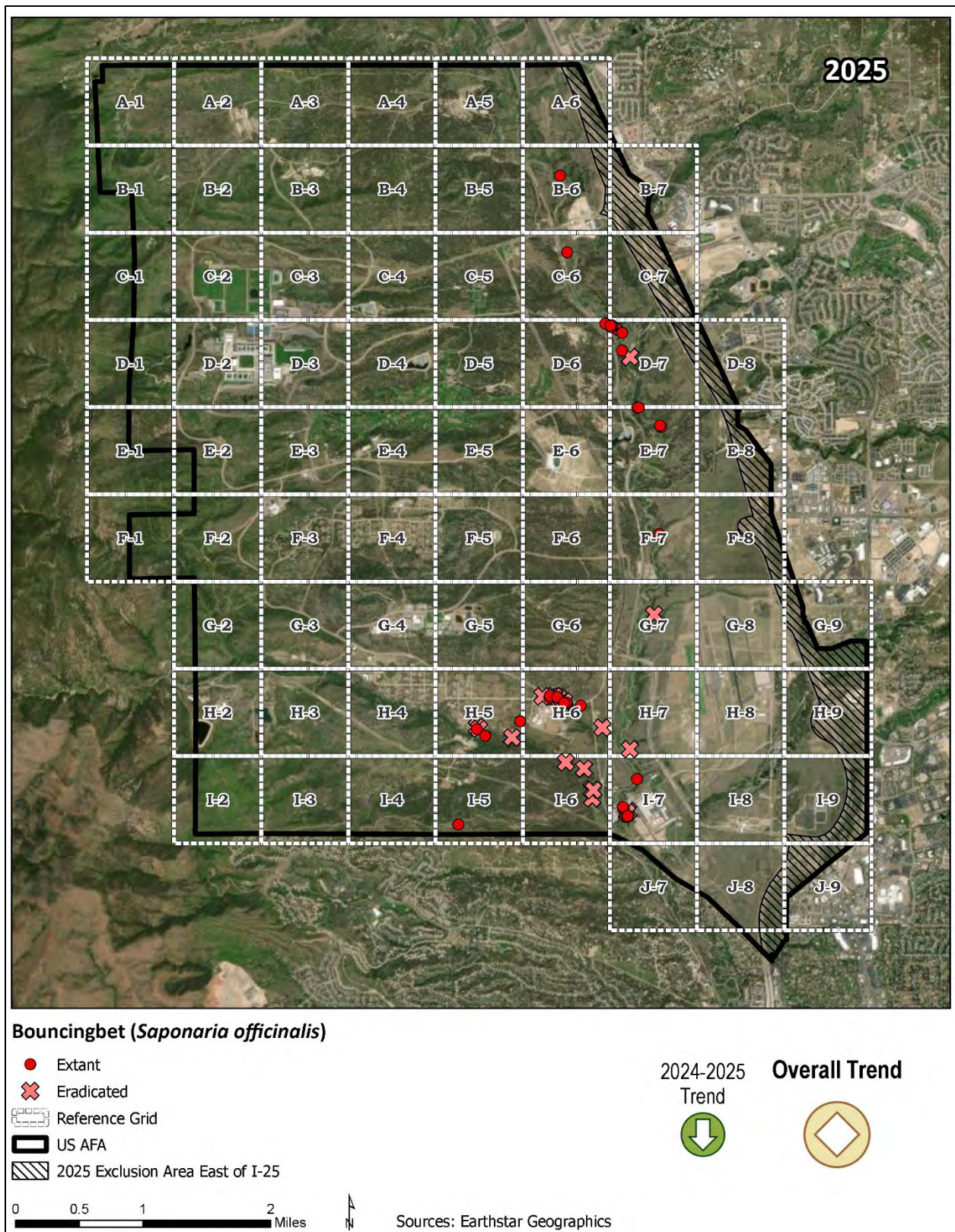
- Bouncingbet was mapped at one location in 2002 and not surveyed again until 2013.
- In 2013, three distinct areas were mapped, but distribution was still localized.
- The westernmost infestation was huge, representing almost 40,000 individuals.
- The 2013 locations were treated by the Academy.
- In 2014, there was a decrease in the number of extant features.
- In 2015, the number of extant features was identical to those in 2013. A small population has resurfaced near the huge infestation that was discovered and thought to be eradicated in 2013. Some new locations were mapped in 2015 but several previously treated sites are repopulating.
- In 2016–2017 all known bouncing bet sites with extant plants that had flower tops were grazed by wildlife. Previously treated sites showed damage from overspray and the return of bouncingbet to the chemically treated sites.
- The first year for basewide mapping for bouncingbet is 2018. The data show an overall decrease since it was first mapped in 2013, with an increase in mapped features.
- In 2019, there was an increase in mapped features and a decrease in number of individuals.
- In 2020, there was a decrease from 2019 in numbers of individuals, occupied acres, and an increase in eradicated sites. The very dry conditions of 2020,

shoreline flooding and perhaps continuous removal of reproductive parts have contributed to the decrease.

- In 2021, we estimate bouncingbet is decreasing. Not all sites were visited in 2021.
- In 2022, no surveys or treatments were undertaken.
- In 2023, we estimate bouncingbet has increased since 2021. We visited almost all the known sites and found a large number of individuals in flower. We clipped the flowers and revisited to treat again later in the summer. New flowers were present later in the season.
- In 2024, during basewide mapping at the Academy all known sites were visited, and a large number of individuals were found in flower. Grazing by ungulates continues to be found which is assisting with the suppression of the species.
- In 2025, there has been a modest decrease in the estimated number of individuals at the Academy. The population of bouncingbet appear to be stable although we continue to see fluctuations in the year-to-year numbers.



Map 57. Distribution of bouncingbet at the Academy between 2002 and 2025.



Map 58. Distribution of bouncingbet at the Academy in 2025 with the reference grid.

Bladder Campion (*Silene latifolia*)

Trend: Unknown, mapping began in 2024 and the species is only partially mapped at the Academy.

Management Goals: Considering Management

State List: Not Listed in Colorado



- Annual or short-lived perennial herbs (Morton, 2020)
- Plants are finely hairy on nearly all surfaces (finely hirsute to glandular-puberulent) (Morton, 2020)
- Reproduces by seed and short rhizomes.
- Five deeply cleft, white to pink petals which can appear like ten petals without close examination. (Morton, 2020)
- The flowers of female plants will become inflated at the base as they grow and have twenty veins (Morton, 2020)
- Sometimes introduced from tainted alfalfa, clover, or grass seed (Praciak, 2022)
- One plant can produce as many as 25,000 seeds (Praciak, 2022)



Figure 56. Dew covered *Silene latifolia* found along Monument Creek in Sept. 2024 – Photos by Robert Monahan

2025 Mapping Results

Bladder campion was mapped for the first time in 2024 along West Monument Creek (Map 59). The species has been known to occur at the Academy prior to 2024 along West Monument Creek and the southern portion of Monument Creek. It was found extensively along West Monument Creek in 2024 and below the confluence of West Monument and Monument Creek. Just two new features were found in 2025 (Map 59, Table 55).

Table 55. Mapping of bladder campion at the Academy.

Year	Occupied Acres	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2024	0.19	2,613	32	0
2025	0.19	2,646	34	0

Recommendations

Bladder campion is currently a low priority because it is not on the Colorado Noxious Weed List, and it is not yet known if this species will require management. The species has a low cover, and the majority of locations are found in the West Monument Creek area. Eradication would likely be difficult and resource intensive due to its prolific seed production and potential for reintroduction; therefore, it is recommended that opportunistic mapping for bladder campion continues, and the species be contained to the West Monument Creek area. The seed longevity of this plant is not known. Although this plant is not on the State of Colorado noxious weed list, it has been shown to be aggressive in Washington state and throughout the northern U.S. It is found on the edge of disturbed riparian areas with many native shrubs and herbs at the Academy. Mowing or removing flowers by hand may be effective treatments to reduce the number of seeds produced (Praciak, 2022).

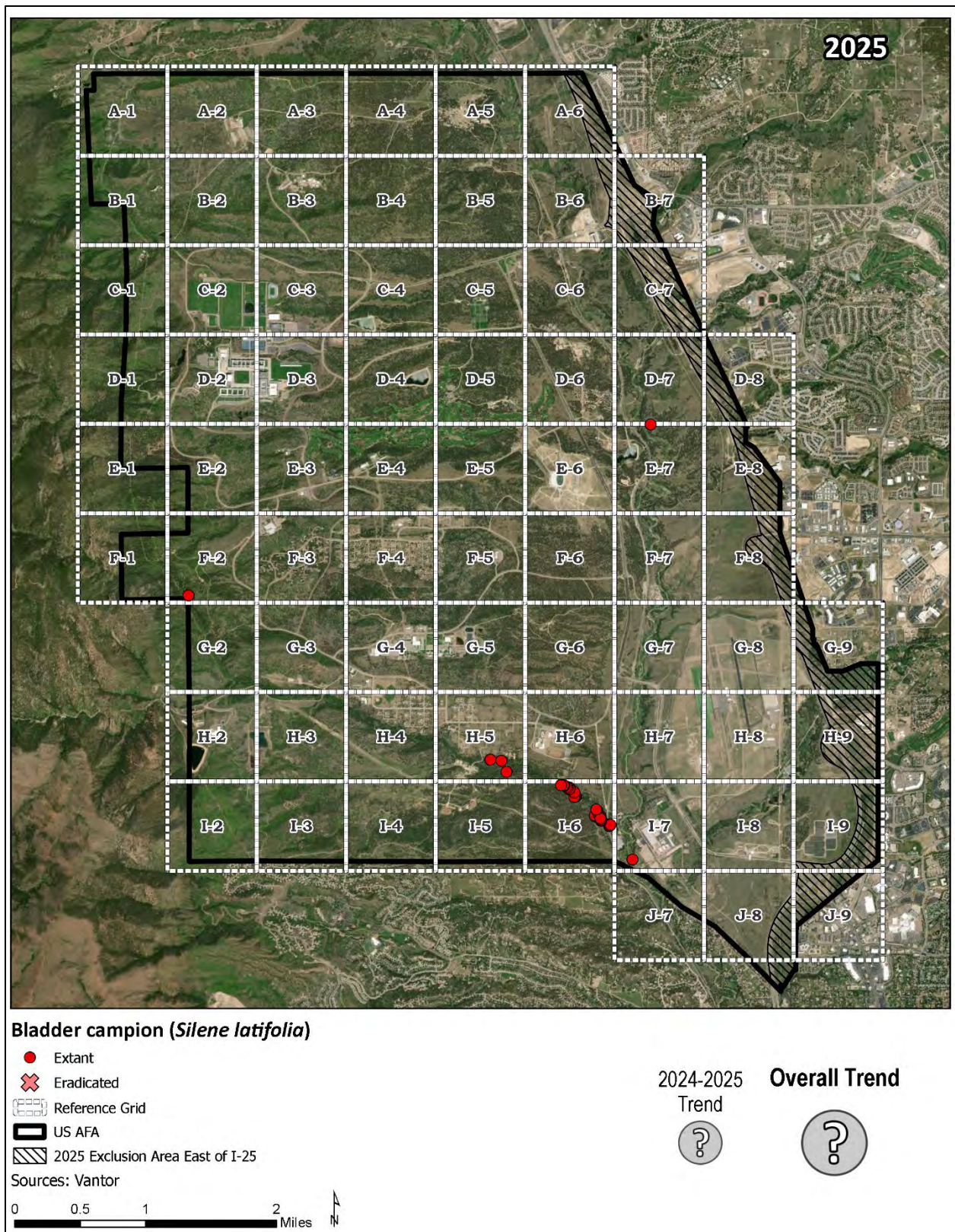
Recommendations for bladder campion:

- There are native *Silene* species which occur at the base that look similar to bladder campion (*Silene latifolia*) so correct identification is critical for all mapping and monitoring efforts.
- Monitor known locations to see if the population is stable or increasing.
- Opportunistically map bladder campion in other riparian zones at the Academy, especially upstream along Monument Creek to detect any new populations early.

- Opportunistically remove, collect, and destroy/dispose of flowering parts to reduce seed production. Seeds will mature and germinate if left on the ground.
- Look for potential seed sources along West Monument Creek.

History of Sampling and Treatment

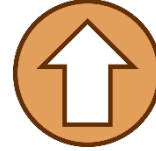
- In 2024, basewide mapping was conducted at the Academy and bladder campion was mapped for the first time. Bladder campion is known to have occurred at the base for many years but has not been mapped. The species was found along West Monument Creek and along the southern portion of Monument Creek.
- In 2025, bladder campion was opportunistically mapped at two new locations.



Map 59. Distribution of bladder campion at the Academy in 2025 with the reference grid.

Salt Cedar (*Tamarix ramosissima*)

Change from 2024–2025: Increasing
Management Goals: Eradication – Rapid Response
State List: B



- Tall shrub or small tree
- Sprouts from stump when cut.
- Reproduction by roots, submerged stems, and seeds (Lindgren et al., 2010)
- Flowers April–September
- Seed longevity is short, approx. 6 months (Lindgren et al., 2010)
- Seed dispersed by wind, water, and birds (Lindgren et al., 2010)
- Provides habitat for nesting birds (Zouhar, 2003b)



Figure 57. (left) *Tamarix ramosissima* flowers; (right) *Tamarix ramosissima* branch and its scale-like leaves – Photos by Andrey Zharkikh from Salt Lake City, USA, [CC BY 2.0](#), via Wikimedia Commons.

2025 Mapping Results

In 2025, two new extant locations of salt cedar were mapped on a tributary of Monument Creek near Interstate 25 (Figure 58). All other sites are thought to be extirpated (Table 56, Map 60, and Map 61). This species has an exceedingly high likelihood of being eradicated, although reintroductions along Monument Creek and its tributaries will likely continue into the future.

Table 56. Mapping of salt cedar at the Academy during the first pass.

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002	<0.01	1	1	0
2007	<0.01	1	1	1
2008	0	0	0	1
2009	<0.01	2	2	3
2010	0	0	0	5
2011	<0.01	1	1	4
2012	<0.01	1	1	4
2013	<0.01	1	1	5
2014	<0.01	1	1	6
2015	0.03	6	4	5
2016	<0.01	1	1	8
2017	<0.01	1	1	8
2018	<0.01	2	2	8
2019	<0.01	1	1	9
2020	<0.01	1	1	9
2021	<0.01	1	1	9
2022	---	---	---	---
2023	<0.01	3	3	9
2024 ¹	<0.01	1	1	10
2025 ²	<0.01	2	2	11

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹One site east of I-25 was not included in the 2024 mapping or analysis. This site was eradicated from 2007 to 2021 and not been monitored from 2022 to 2024.

²Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.



Figure 58. The two salt cedar individuals found at the Academy in 2025 – Photo by Rob Monahan

2025 Treatment

In 2025, two individuals were mapped on a tributary of Monument Creek (Figure 58, Map 61). This species is treated by Academy staff (Table 57).

Table 57. Monitoring and treatment of salt cedar sites at the Academy in 2024.

Pass & Year	# Site Visits	# Shoots Mapped	# Manually Treated Shoots	# Sites with Plants	# Sites without Plants
2025 Pass 1	7	2	---	2	5
2025 Total	7	2	---	---	---
2021	2	1	---	---	---
2022	---	---	---	---	---
2023	7	3	2	---	---
2024¹	14	1	---	---	---
2025	7	2	---	---	---

¹ One site east of I-25 was not included in the 2024 mapping or analysis. This site was eradicated from 2007 to 2021 and not been monitored from 2022 to 2024.

Recommendations

Management urgency for salt cedar is considered to be high due to low cover and high potential for eradication.

Recommendations for salt cedar:

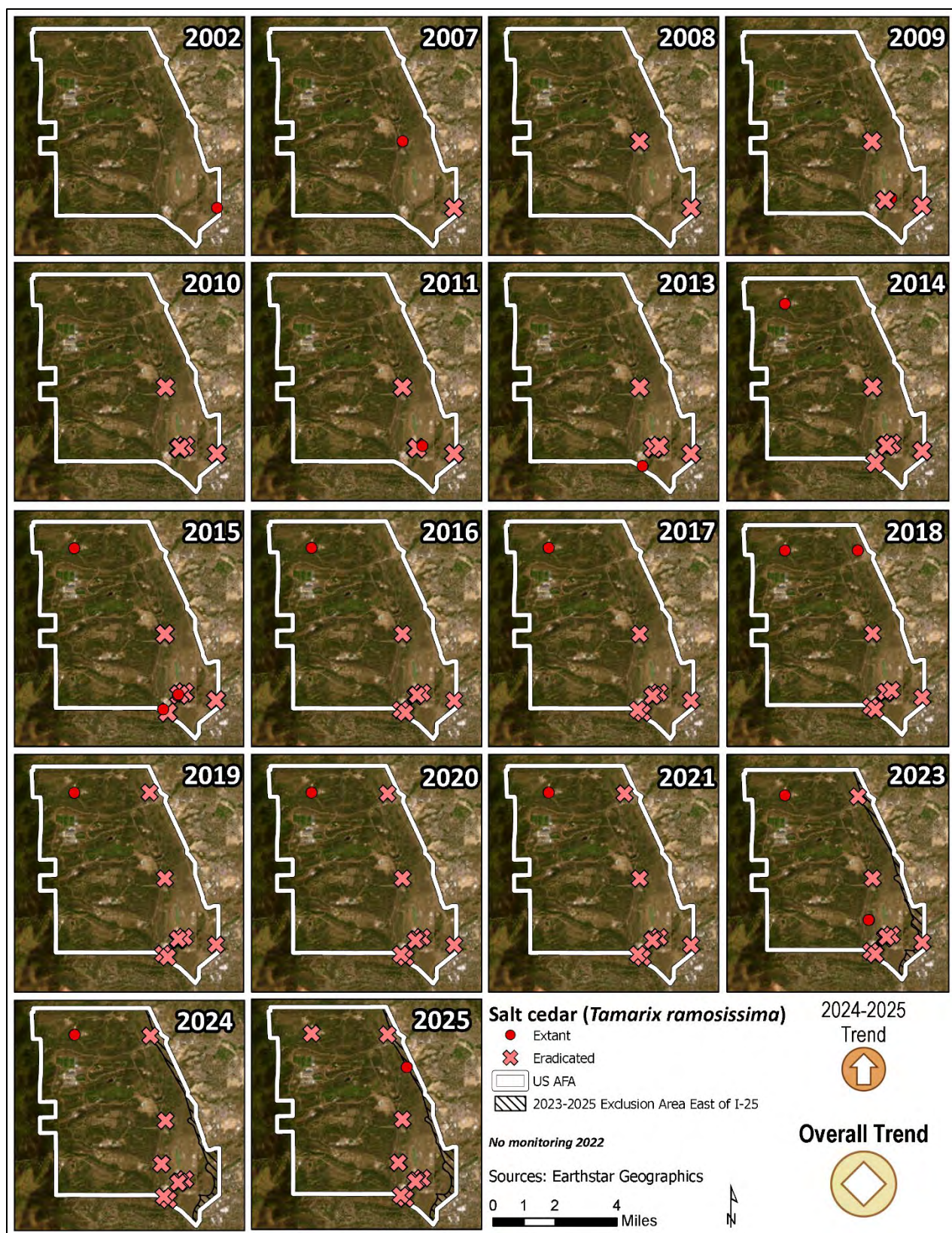
- Continue to monitor known sites.
- Be on the lookout for salt cedar in ditches, drainages, and floodplains.

The Academy is treating the known extant sites using a cut stump with herbicide method recommend for salt cedar. For this method to be effective, plants are cut as close to the ground as possible (within 5 cm). According to Colorado Natural Areas BMPs for salt cedar, herbicide should be applied immediately (within seconds) to the cut as the wound will heal quickly and decrease the amount of herbicide translocated into the stump (CPW 2013). Herbicide should be applied around the perimeter of the cut stump or stems. The two herbicides recommended by Colorado State Parks for this method are triclopyr and imazapyr (CPW 2013). Staff and contractors should monitor eradicated sites as well as ditches, drainages, and riparian areas for new occurrences at the Academy.

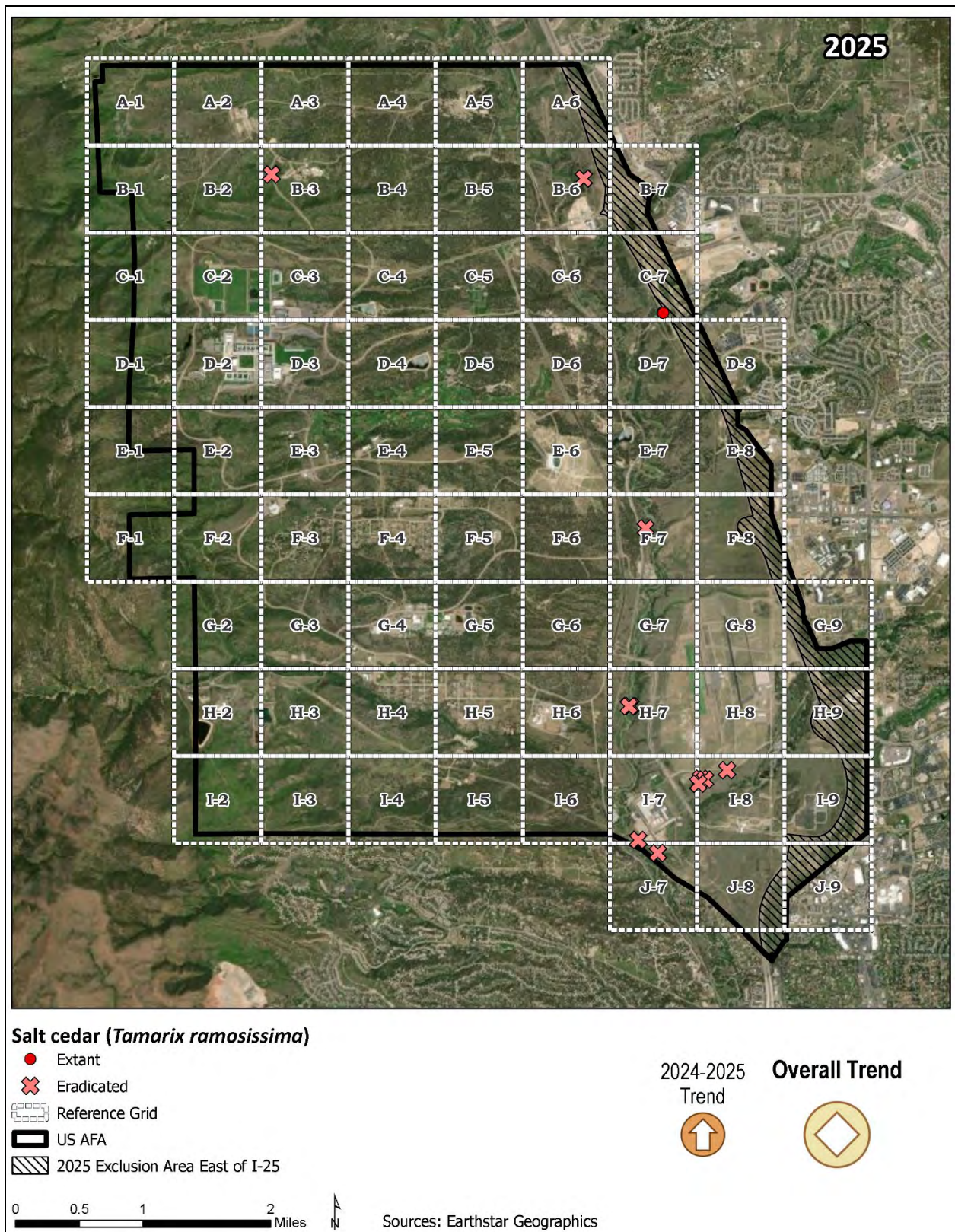
History of Sampling and Treatment:

- Salt cedar was known from five separate sites between 2002 and 2013.
- In 2008 and 2010, no plants were observed at the Academy.
- Between 2011 and 2014, the number of individuals remained stable with one plant documented each year.
- In 2015, two new sites included four individuals; one previously known extant site had been manually cut and was re-sprouting. This year's survey represented an increase in the number of extant features monitored from one to four. Five monitoring sites were found to have no living salt cedar plants in 2015.
- In 2016, six out of nine sites visited had no salt cedar present, two sites were not visited in 2016 (one near the airport and one across I-25, both of which were not found in 2015). One site had seven sprouts at Jacks Valley in 2016.
- In 2017, eight of nine sites with salt cedar were visited; the only site with salt cedar present was in Jacks Valley. The sprouts appear to have been browsed by wildlife.
- In 2018, two extant locations of salt cedar were mapped, each with a single individual. Natural Resource Managers pulled them in 2018.
- In 2019, there was only one extant location of salt cedar.

- In 2020, only one extant location was observed out of five sites visited. The five sites not visited were located along the south side of the airfield and one east of I-25, all did not have plants present in 2019.
- In 2021, one extant feature was located out of two sites visited.
- In 2022, no surveys or treatments were undertaken.
- In 2023, two new seedling individuals were found along Monument Creek approximately twenty meters apart. Both seedlings were manually treated by CNHP staff. The known Jack's Valley West occurrence was still extant and is being treated by Academy staff.
- In 2024, during basewide mapping at the Academy no new individuals were found and only one individual was relocated. The known occurrence in Jack's Valley West was extant and continues to be treated by Academy staff.
- In 2025, two salt cedar individuals were found off a tributary of Monument Creek. All other locations at the Academy are eradicated.



Map 60. Distribution of salt cedar at the Academy between 2002 and 2025.



Map 61. Distribution of salt cedar at the Academy in 2025 with the reference grid.

Common Tansy (*Tanacetum vulgare*)

Change from 2024–2025: Rapidly Increasing
Management Goals: Eradication – Rapid Response
State List: B



- Perennial, woody forb, with wire-like root system.
- Reproduction by seed and from shallow rhizomes (Jacobs, 2009a).
- Seeds can remain viable on dried heads to three years (White, 1997).
- Plants usually only spread short distances but can be accidentally spread farther through anthropogenic means (Jacobs, 2009a).
- Volatile oils produced by common tansy deters grazing by livestock and give the plant a menthol or camphor scent when crushed (Jacobs, 2009a).
- Escaped ornamental (Jacobs, 2009a).



Figure 59. (left) Flowering heads of *Tanacetum vulgare* at the Air Force Academy in 2024—Photo by Robert Monahan. (right) *Tanacetum vulgare* found at the Academy in 2020—Photo by Pam Smith

2025 Mapping Results

A new location with an estimated 420 common tansy individuals was found off Monument Creek in 2025. None of the plants found were flowering at the time of the visit. This new location is far from the only other place this species has been found at the Academy and this new location is well established. Common tansy (List B noxious weed) was added to the weed list at the Academy in 2020 and until this year has only been found growing in small quantities (Table 58, Map 62, and Map 63).

Table 58. Mapping of common tansy at the Academy during the first pass.

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002	---	---	---	---
2007	---	---	---	---
2012	---	---	---	---
2018	---	---	---	---
2020	<0.01	15	1	0
2021	<0.01	1	1	0
2022	---	---	---	---
2023	<0.01	0	0	1
2024	<0.01	2	1	1
2025 ¹	0.01	420	1	2

Basewide weed mapping was performed in 2002, 2007, 2012, 2018, and 2024, which are the shaded rows.

¹Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

2025 Treatment

In 2025, all 420 individuals found were manually treated. Common tansy remains eradicated at the other known locations (Table 59).

Table 59. Monitoring and treatment of common tansy sites at the Academy in 2024.

Pass & Year	# Site Visits	# Shoots Mapped	# Manually Treated Shoots	# Sites with Plants	# Sites without Plants
2025 Pass 1	3	420	420	1	2
2025 Pass 2	1	0	0	0	1
2025 Total	4	420	420	---	---
2019	---	---	---	---	---
2020	1	15	0	---	---
2021	3	5	5	---	---
2022	---	---	---	---	---
2023	1	0	0	---	---
2024	4	2	2	---	---
2025	4	420	420	---	---

Recommendations

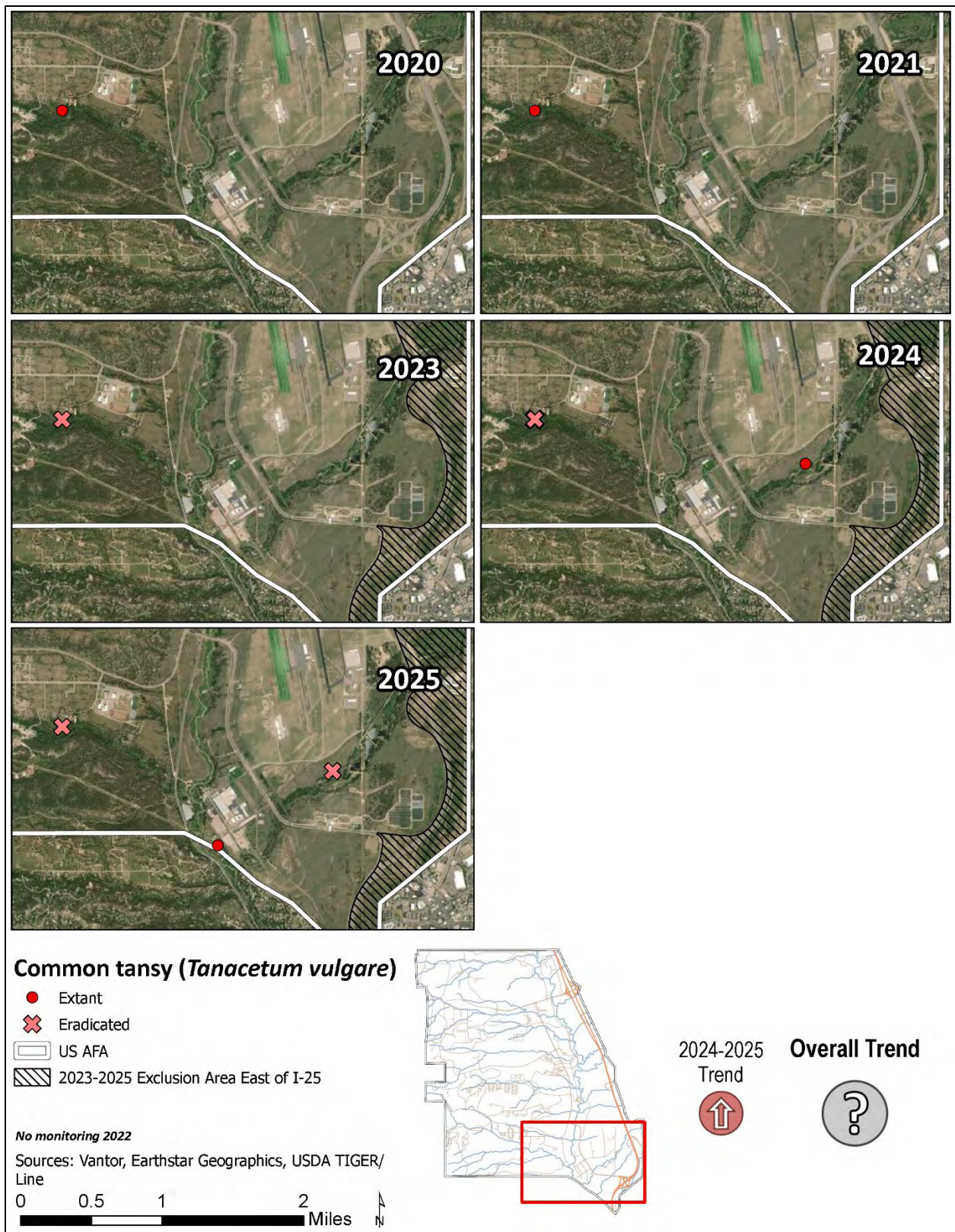
Management urgency for common tansy is high due to low cover and high potential for eradication.

- Continue to monitor and treat all known sites.
- Be on the lookout for common tansy along Kettle Creek and along the southern end of Monument Creek.
- Remove as much of the root system as possible, limiting soil disturbance.
- Remove all sprouts, flower heads and seeds from the site.

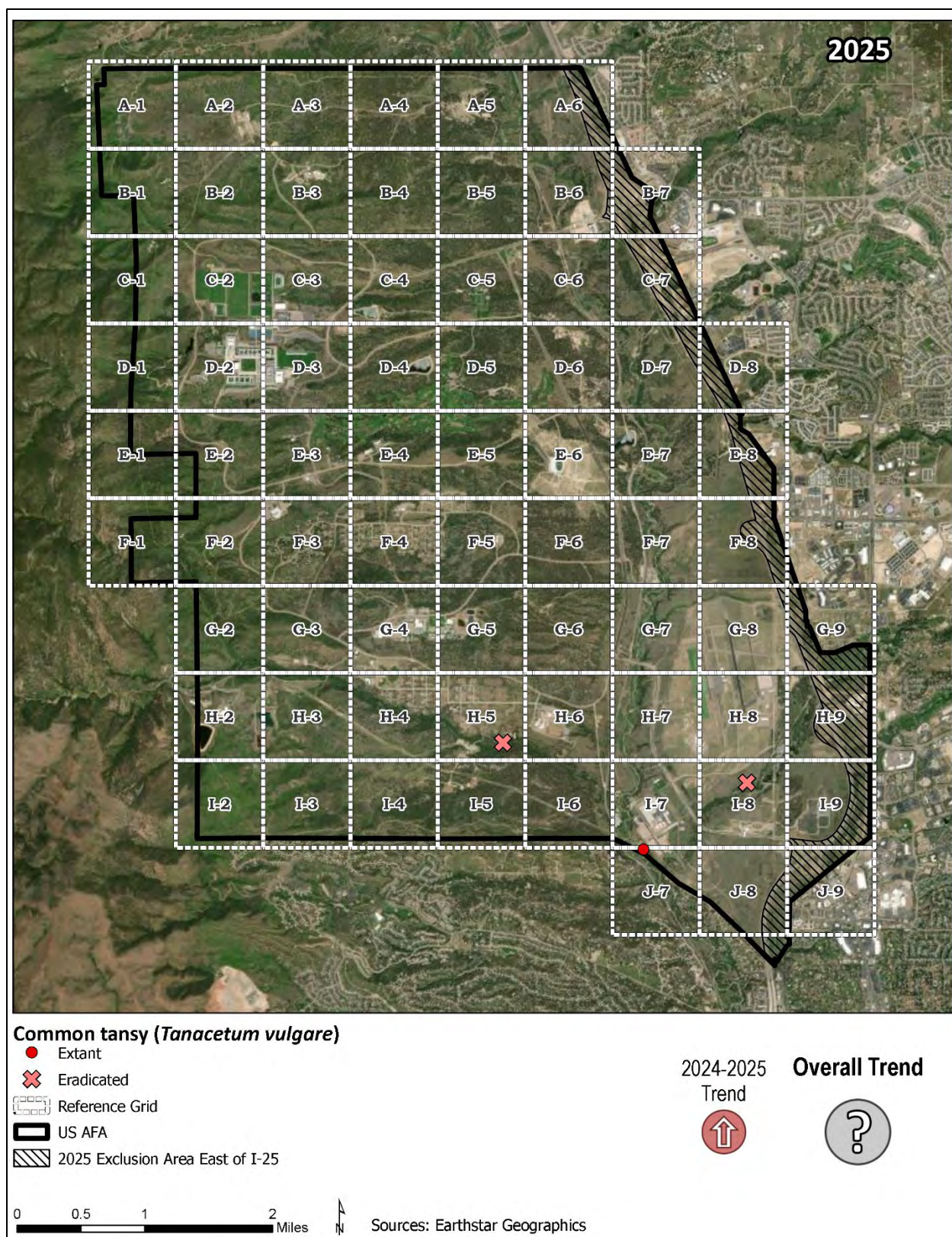
Common tansy has an extensive root system but most of the reproduction is from seeds. The seeds have a relatively short longevity (2–3 years) and efforts to prevent flowering and the removal of sprouts and roots should result in successful treatments (White 1997). At one site where common tansy was located is also where several garden escape species have been observed. The area is downslope of residences with manicured lawns and gardens that have been discarding yard waste into the drainage and where seeds and plant fragments have likely been transported off these properties during rain or snow melt into the West Monument Creek drainage. Contacting the residents is recommended as some of the species have been quite invasive at the Academy and include garlic mustard and yellow spring bedstraw. Hoary alyssum (Colorado Department of Agriculture Watch List Noxious Weed) has also been observed there along with non-native shrubs and grasses found on manicured properties.

History of Sampling and Treatment:

- In 2020, common tansy was added to the monitoring list for the Academy.
- In 2021, sprouts and underground roots were manually treated throughout the growing season.
- In 2022, no surveys or treatments were undertaken.
- In 2023, the individual treated in 2021 was not present in 2023. We did not find any individuals.
- In 2024, during basewide mapping at the Academy one new site was found along Kettle Creek, and two individuals were treated. The only other known location continues to remain eradicated.
- In 2025, a new site was discovered, and all 420 mapped common tansy individuals were manually treated.



Map 62. Distribution of common tansy at the Academy between 2020 and 2025.



Map 63. Distribution of common tansy at the Academy in 2025 with the reference grid.

Scentless Chamomile (*Tripleurospermum inodorum*)

Change from 2024–2025: Unable to assess trend.

Management Goals: Rapid Response on Kettle Creek,
Containment on Monument Creek

State List: B



- Annual forb.
- Seedlings emerge in the spring, and plant flower from June to October.
- Seedlings can produce a dense mat, out competing other species.
- Seeds and flowers are continually formed throughout the growing season.
- Each plant can produce roughly 6,300–34,000 seeds (Lutman, 2002; Kay, 1994).
- Seed longevity is at least 10 years (Kay, 1994).
- Habitats roadsides, streambanks, and drainages.



Figure 60. (left) *Tripleurospermum inodorum* growing in sandy soil as in immature plant, and (right) flowering plant – Photos by AnRo0002, CC0, via Wikimedia Commons

2025 Mapping Results

Scentless chamomile is widespread in Monument Creek with hundreds of known sites along the creek (Table 60, Map 64, and Map 65). Seed is thought to be coming from a large chamomile population upstream of the Academy. Mapping of this species along Monument Creek was partial in 2024 and 2025, and only 144 sites were visited in 2024 and just 84 sites in 2025. Due to incomplete mapping and the ever-shifting populations, the trend of scentless chamomile cannot be accurately assessed but it is likely increasing at the base. Kettle Creek was where Scentless

chamomile was first observed at the Academy in 2016. There are still six known sites at Kettle Creek, two of which were extant in 2025.

Table 60. Mapping of scentless chamomile at the Academy.

Year	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
2002	---	---	---	---
2007	---	---	---	---
2012	---	---	---	---
2016	<0.01	2	1	0
2017	<0.01	1	1	1
2018	0.41	2,530	117	2
2019	0.42	2,525	116	3
2020	0.40	2,462	112	8
2021	0.39	2,599	102	18
2022	---	---	---	---
2023	2.09	2,528	140	44
2024	2.49	2,383	165	63
2025¹	2.18	2,886	153	85

Basewide weed mapping performed during shaded years.

¹Supplementary basewide mapping was performed in 2025 to capture select areas that were not mapped in the 2024 basewide survey.

2025 Treatment

In 2025, 84 site visits were made and 1,307 individuals were treated by CNHP staff (Table 61). Scentless chamomile was mapped and treated only when visiting nearby higher priority species this year (Figure 61). Staff from the Natural Resource office at the Academy also treated many populations in 2025.



Figure 61. Ali Lamberson holding the largest scentless chamomile treated in 2025 – Photo by Rob Monahan.

Table 61. Monitoring and treatment of scentless chamomile sites at the Academy in 2025.

Pass & Year	# Site Visits	# Shoots Mapped	# Manually Treated Shoots	# Sites with Plants	# Sites without Plants
2025 Pass 1	82	1,276	1,162	43	39
2025 Pass 2	2	196	145	2	0
2025 Total	84	1,472	1,307	---	---
2021	18	251	251	---	---
2022	---	---	---	---	---
2023	189	2,555	1,161	---	---
2024	145	930	515	---	---
2025	84	1,472	1,307	---	---

Recommendations

Management urgency for scentless chamomile is moderate for Kettle Creek and low for Monument Creek.

Recommendations for scentless chamomile:

- Contact and work with landowners upstream of the Academy to find the source population and work on strategies to reduce the number of seeds flowing down Monument Creek.
- Consider new management strategies for Monument Creek.
- Continue to monitor Kettle Creek for new occurrences of scentless chamomile.

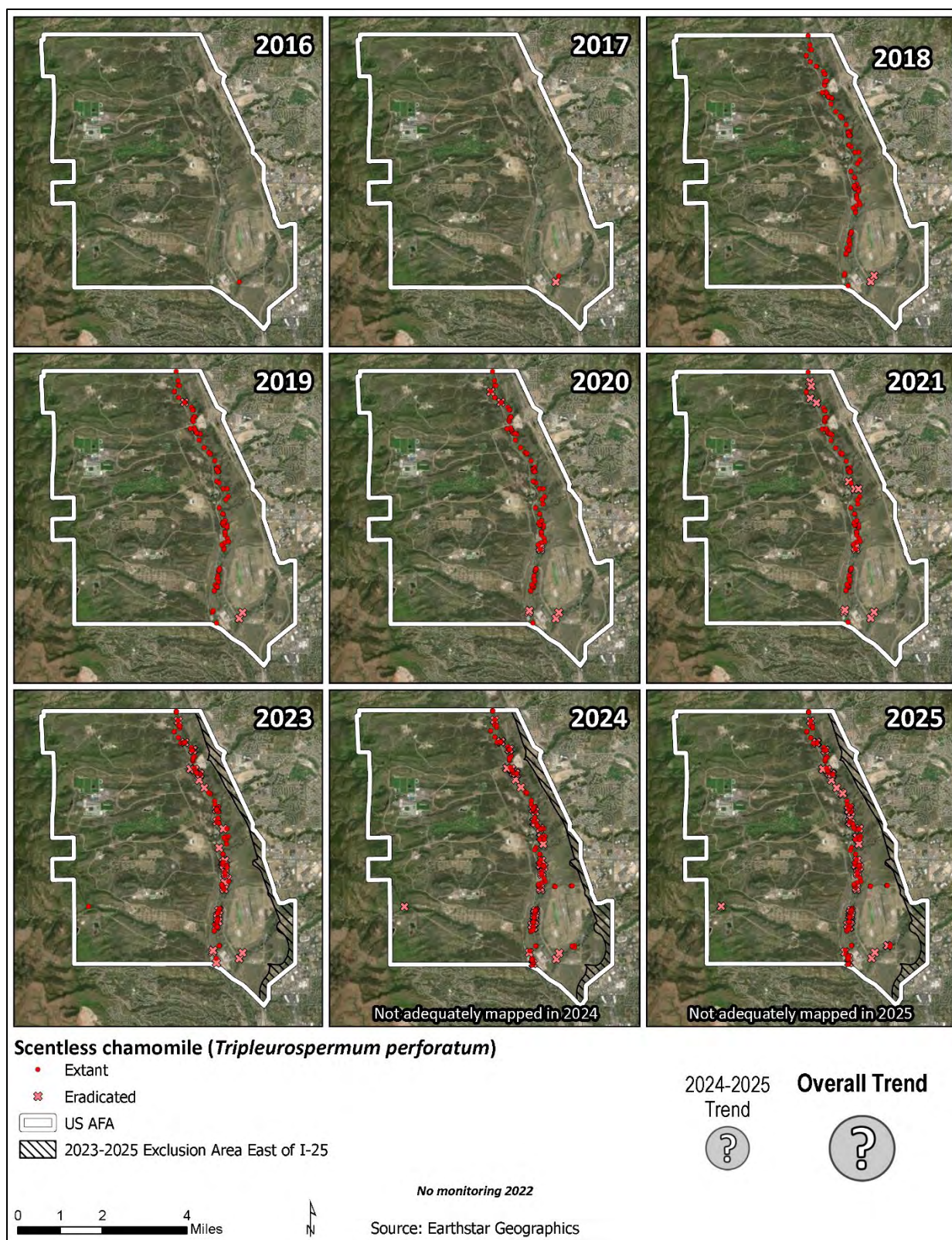
From 2023 to 2025, pulled plants were moved out of the drainage and left to desiccate instead of carrying them back for disposal. The Monument Creek floodplain is exceptionally large in many areas. Carrying the large biomass out of the drainage across densely vegetated floodplains is impractical. In addition, considering the frequent and extremely flashy flooding cycles it would be difficult to remove the seed sources of the pulled plants out of the local watershed. These characteristics, along with approximately six linear miles of floodplain and at least 215 known locations make control or treatment a large undertaking. In addition, inputs from upstream that likely supply a continuous flow of scentless chamomile seeds combined with the continuous flooding disturbances may make it impractical and perhaps futile to put a large amount of effort into treating this species.

History of Sampling and Treatment:

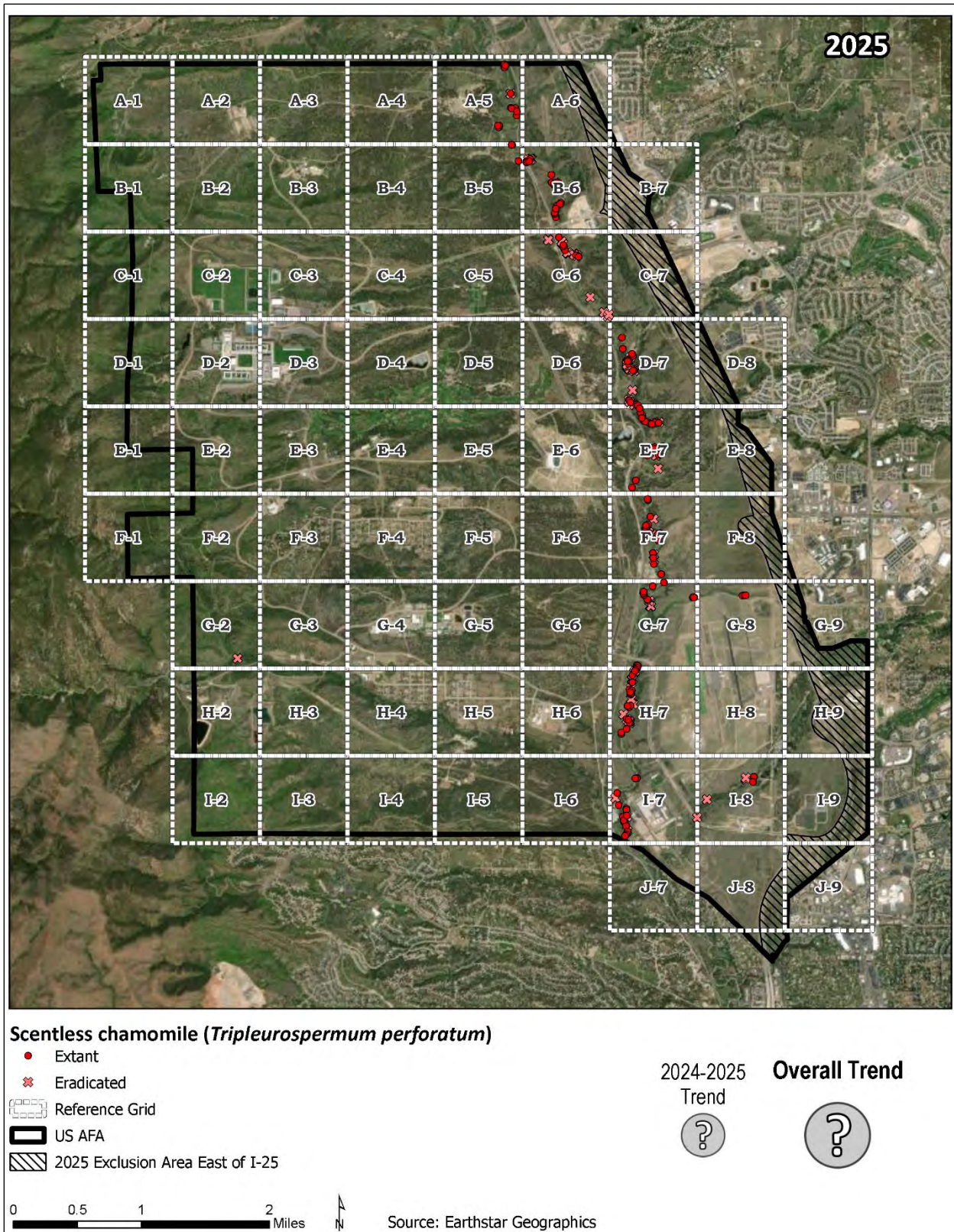
- The first observation of scentless chamomile was in 2016 at the Academy. It was also a county record for El Paso County. Two individuals were found along

the Kettle Creek drainage. An herbarium specimen was deposited at Colorado State University to document the county record.

- In 2017, a new location with a single individual was observed (and pulled) about 250 meters from the original site. The original site was also visited, and no plants were found.
- In 2018, the first basewide mapping for noxious weeds was conducted since scentless chamomile had been discovered in 2016. Over 2,500 plants were mapped along Monument Creek, and none were mapped on Kettle Creek where it was originally found.
- In 2019, it was apparent there were too many plants along Monument Creek to consider eradication as a goal. Kettle Creek and all other small drainages should still be targeted for rapid response activities. For Monument Creek, restoration and planting of native species may be the only way to control scentless chamomile.
- In 2020, we visited only a portion of the known sites (23 sites) to monitor previously treated areas to see if the plants were returning. We found that eight of the sites had remained free of plants for one or more growing seasons. A plan to coordinate efforts with the Academy staff will be implemented to remove more scentless chamomile plants along Monument Creek in 2021 and to carefully monitor other drainages at the Academy.
- In 2021, we visited 18 sites with hopes of treating many more sites. The treatments along Monument Creek need to be re-evaluated at the spring meeting in 2022.
- In 2022, no surveys or treatments were undertaken.
- In 2023, there was an increase in survey and treatment effort for scentless chamomile along Monument Creek. This increase in effort may explain the substantial increase in both extant and eradicated features.
- In 2024, basewide mapping was conducted at the Academy and scentless chamomile was incompletely mapped along Monument Creek and four new locations were discovered on Kettle Creek.
- In 2025, scentless chamomile was mapped and treated only when visiting nearby higher priority species. 1,307 individuals were treated across 82 sites by CNHP staff.



Map 64. Distribution of scentless chamomile at the Academy between 2016 and 2025.



Map 65. Distribution of scentless chamomile at the Academy in 2025 with the reference grid.

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APPENDIX A. SUMMARY OF MONITORING BY SPECIES AT THE ACADEMY SINCE 2002

Table 62. Summary of species monitored by year at the Academy.

Monitoring activities (not necessarily mapping) are indicated by brown shading. M = mapped, PM = partially mapped,

* Indicates the first year a species was mapped.

Species	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
garlic mustard (<i>Alliaria petiolata</i>)																	M*	M	M	M		M	M	M
Siberian peashrub (<i>Caragana arborescens</i>)											PM						M						M	PM
musk thistle (<i>Carduus nutans</i>)	M					M					PM						M						M	PM
diffuse knapweed (<i>Centaurea diffusa</i>)	M					M					PM						M						M	PM
diffuse / spotted knapweed hybrid (<i>C. x psammogena</i>)				M*		M					PM						M						M	PM
spotted knapweed (<i>Centaurea stoebe</i> ssp. <i>micranthos</i>)	M			M	M	M					PM						M						M	PM
Canada thistle (<i>Cirsium arvense</i>)	M					PM					PM						M						M	PM
bull thistle (<i>Cirsium vulgare</i>)	M					M					PM						M						M	PM
field bindweed (<i>Convolvulus arvensis</i>)	M					M																		
houndstongue (<i>Cynoglossum officinale</i>)								M*	M	M	PM	M	M	M	M	M	M	M	M	M		M	M	M
common teasel (<i>Dipsacus fullonum</i>)	M					M					PM						M						M	PM
Russian-olive (<i>Elaeagnus angustifolia</i>)	M	PM		PM		M					PM						PM						M	PM
myrtle spurge (<i>Euphorbia myrsinites</i>)				M*	M	M		M	M	M	PM	M	M	M	M	M	M	M	M	M		M	M	M
leafy spurge (<i>Euphorbia virgata</i>)	M					M					PM						M						M	PM
yellow spring bedstraw (<i>Galium verum</i>)									M*	M	PM	M	M	M	M	M	M	M	M	M		M	M	M

Species	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
dame's rocket (<i>Hesperis matronalis</i>)											PM*		PM	M	PM		M	PM	PM	PM		PM	PM	PM
orange hawkweed (<i>Hieracium aurantiacum</i>)																	M*	M	M	M		M	M	M
common St. John's wort (<i>Hypericum perforatum</i>)	M			M	M	M	M	M	M	M	PM	M	M	M	M	M	M	M	M	M		M	M	M
hoary cress (<i>Lepidium draba</i>)	M	M				M					PM						M						M	PM
perennial pepperweed (<i>Lepidium latifolium</i>)																	M*	M	M	M		M	M	M
oxeye daisy (<i>Leucanthemum vulgare</i>)																		M*	M	M		M	M	M
Dalmatian toadflax (<i>Linaria dalmatica</i>)								M*	M	M	PM	M	M	M	M	M	M	M	M	M		M	M	M
yellow toadflax (<i>Linaria vulgaris</i>)	M					PM					PM						PM							PM
Marrow's honeysuckle (<i>Lonicera morrowii</i>)																							PM*	PM
Tatarian honeysuckle (<i>Lonicera tatarica</i>)							M*			M	PM	M	M	M	M	M	M		PM	PM		PM	M	PM
Scotch thistle (<i>Onopordum acanthium</i>)	M			M	M	M	M	M	M	M	PM	M	M	M	M	M	M	M	PM	PM		PM	M	M
Russian knapweed (<i>Rhaponticum repens</i>)			M*	M	M	M	M	M	M	M	PM	M	M	M	M	M	M	M	M	M		M	M	M
bouncingbet (<i>Saponaria officinalis</i>)	M*											M	M	M	M	M	M	M	M	PM		M	M	M
bladder campion (<i>Silene latifolia</i>)																							M*	PM
salt cedar (<i>Tamarix ramosissima</i>)	M					M	M	M	M	M	PM	M	M	M	M	M	M	M	PM	PM		M	M	M
common tansy (<i>Tanacetum vulgare</i>)																			M*	M		M	M	M
scentless chamomile (<i>Tripleurospermum inodorum</i>)															M*	M	M	PM	PM	PM		PM	PM	PM

APPENDIX B. MAPPING PROTOCOL

Noxious weed occurrences were mapped in the field using Arc Field Maps, a portable version of GIS software that allows users to efficiently create and attribute spatial data remotely using an iPad, along with a high precision GPS receiver (1–2.5m accuracy). Arc Field Maps (version 23.2.3) was installed on a fourth generation iPad Pro (iPadOS version 17.6.1) and was linked via Bluetooth to a Bad Elf Flex Mini (version 1.3.4) GPS receiver. Field data was uploaded daily to a central weed map database, hosted on ArcGIS Online, and was accessible to weed mappers, the weed monitoring team, and Natural Resources staff.

Weeds were mapped as points, lines, or polygons, depending on the size and configuration of the occurrence. Linear features were mapped as lines and assigned a buffer width to estimate area. Irregularly shaped features greater than approximately thirty meters in any direction were mapped as polygons. All other features were mapped as points and assigned a radius. Since weeds are mobile from year to year, and the GPS has inherent inaccuracies, weeds of the same species within five meters of each other were mapped as one feature. If previously mapped infestations were not located, they were marked as eradicated, as opposed to deleted, in order to track the soil seed bank and ensure future visits to historically infested areas.

All features were collected using the GPS unless otherwise noted in the attribute table. Features that were inaccessible due to natural barriers or exclosures were digitized “heads-up” using the most recently available arial imagery provided by ArcGIS Online for reference. Attributes were collected using customized field forms, designed to minimize user error by maximizing look-up tables and field auto-population techniques. One free text field was maintained to document any observations deemed important, such as nearby significant species (e.g., rare plants, native thistles) or difficulties incurred in a specific area (e.g., dense oak thickets affecting the ability to map location or estimate individuals). The botany technician had the option to document number of individuals or density as number of individuals per square meter. If density was noted, the number of individuals was calculated in the office by multiplying density by the size of the infestation in square meters.

In 2019, monitoring protocols were adjusted for rapid response species. Occurrences were mapped and attributed and then plants were mechanically removed from

most sites. Occurrences with plants were revisited multiple times during the growing system for most species. Subsequent visits documented the visit date and the number of remaining plants. For consistency, mapping comparisons over the years rely on the footprint of the noxious weed occurrences during the first pass.

Weed data were stored in an ESRI file geodatabase hosted on ArcGIS Online and the following attributes were captured:

Table 63. Geodatabase attributes for the feature table.

Field Name	Field Description
OBJECTID	Unique identifier for the row (auto generated)
ID	Unique identifier for the feature (e.g., Point-1111), used to relate the GIS location to the visit records
Date	Date and time at which the feature of last updated.
PLANS CODE	USDA plants code for the species
SPECIES	Scientific name of the species
COMMONNAME	Common name of the species
NUMINDIV	Number of individuals found
Buffer	Radius for point features; buffer width for line features; not applicable to polygon features
Cover Class	0-1%, Trace; 1-5%, Low; 5-25%, Moderate; 25-75%, High; 75-100%, Very High
Pattern	Continuous, Patchy, NA (for eradicated infestations)
Other Species	Used when a species is not listed as an option in the species dropdown menu
CreationDate	The date and time a feature were first entered into the geodatabase
Creator	ArcGIS Online account which entered the feature into the geodatabase
EditDate	The date and time a feature were last edited in the geodatabase
Editor	ArcGIS Online account which last edited the feature in the geodatabase
Shape	Point, Line, or Polygon (auto generated)

Table 64. Geodatabase attributes for the visit table.

Field Name	Field Description
OBJECTID	Unique identifier for the row (auto generated)
Relate	Unique identifier for the feature (e.g., Point-1111), used to relate the GIS location to the visit records
Date	Date and time of the visit
Status	Extant, Sprouting, Standing Dead, or Eradicated
Number of Individuals	Number of individuals found
Density	The density of individuals found (individuals per square meter)
Pass	Number of individuals found
Number of Treated	Number of individuals treated
CreationDate	The date and time a feature were first entered into the geodatabase
Creator	ArcGIS Online account which entered the feature into the geodatabase
EditDate	The date and time a feature were last edited in the geodatabase
Editor	ArcGIS Online account which last edited the feature in the geodatabase
Shape	Point, Line, or Polygon (auto generated)

Points and lines were buffered and combined with mapped polygons to generate a final weed map depicting our best representation of the distribution of noxious weeds at the Academy. See buffering examples below.

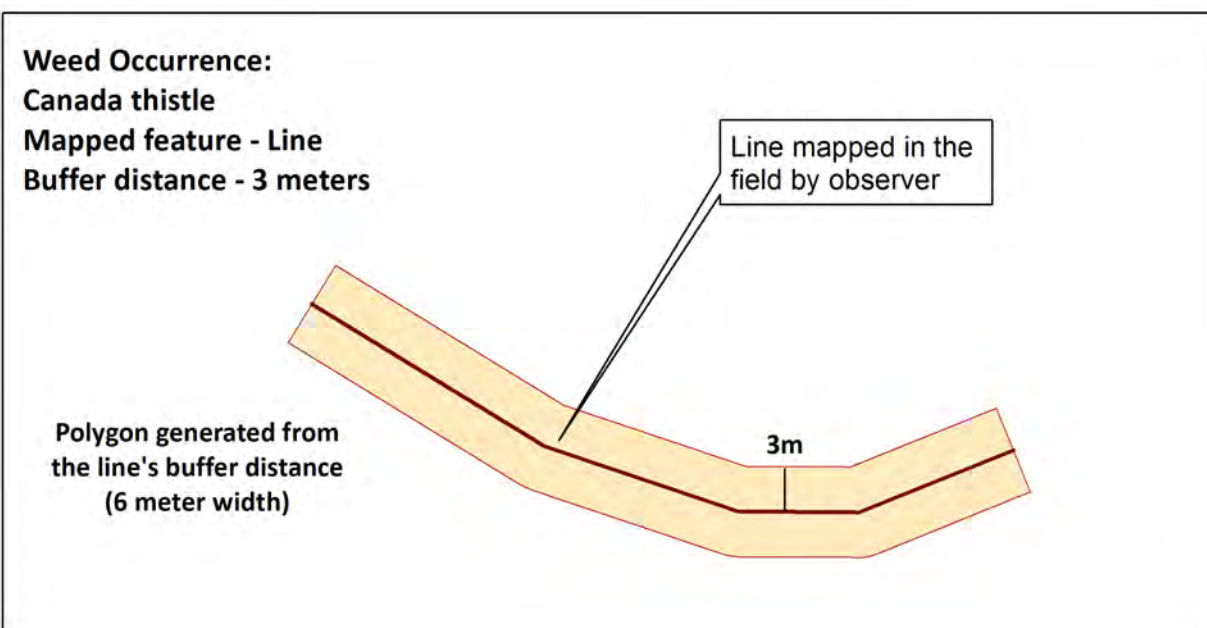
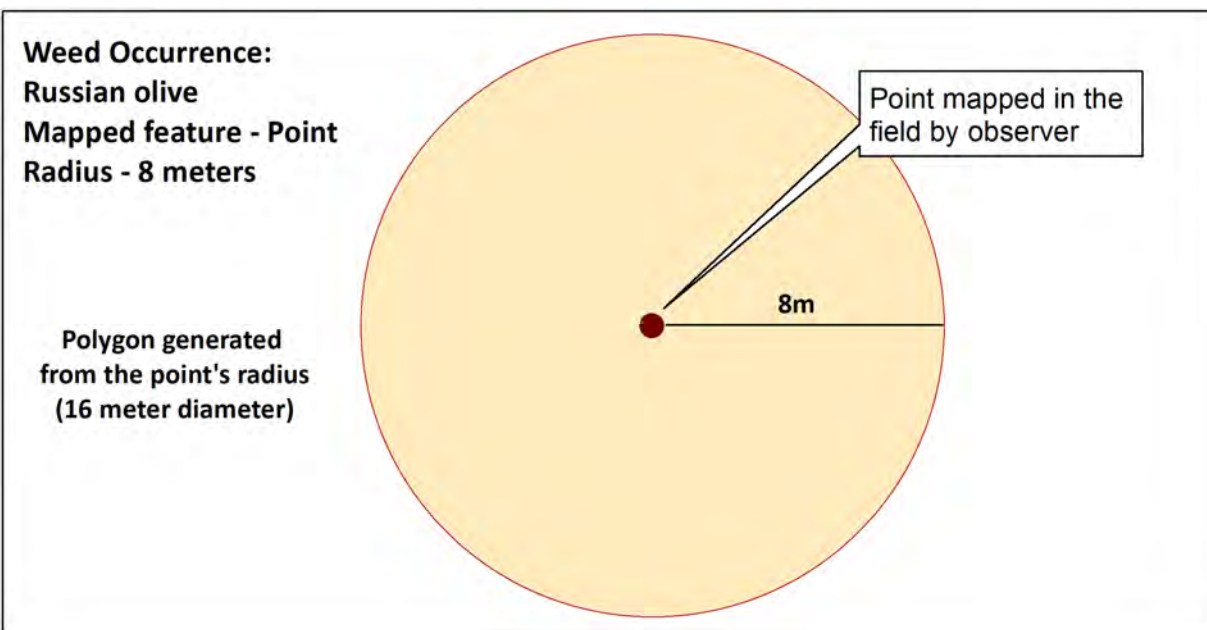


Figure 62. (top) A buffered point and (bottom) a buffered line showing the area a species occupies around a given location.

APPENDIX C. ASSESSMENT WORKSHEET FOR WEED MANAGEMENT SITE PLAN

1. Site location:

2. Size of area with target species:

3. Target species of concern at site:

a. Describe the biological characteristics that will be important for management:

- ☐ Annual with a shallow root system (puncturevine)
- ☐ Biennial species that dies after it flowers (musk thistle, knapweeds, bull thistle, teasel, Scotch thistle, houndstongue)
- ☐ Perennial broad-leaved plant with deep root system (hoary cress, Canada thistle, field bindweed, knapweeds, bouncingbet, St. John's wort, Dame's rocket, scentless chamomile, toadflaxes)
- ☐ Woody plant (salt cedar, Russian olive, honeysuckle, Siberian peashrub)
- ☐ Other

b. Seed longevity: _____ (how long to monitor site)

c. Length of time species of concern has been present at site: _____

d. % cover of target species at site: _____

e. % cover native species: _____

Describe other species present:

4. Site Description (include wildlife use):

a. How is the target species distributed?

- a. ☐ solid stand
- b. ☐ patchy
- c. ☐ linear
- d. ☐ in a depression
- e. ☐ other _____

b. Is the area a wetland? (herbicides should be wetland approved)

- a. ☐ wet or moist soil year round
- b. ☐ periodically flooded
- c. ☐ upland inclusions
- d. ☐ wetland adjacent or part of site

c. Has the site been previously treated? YES/NO. If yes,
how? _____

when? _____

d. Are there ongoing disturbances to the site? (natural and anthropogenic)

- a. ☐ near a road
- b. ☐ trails
- c. ☐ culverts, drains
- d. ☐ grazing (native or livestock)
- e. ☐ off road use by tractors, mowers, four wheelers
- f. ☐ soil disturbed by berm building, digging, ditching
- g. ☐ other _____

5. Surrounding land use description:

6. Are there rare plants or rare plant communities either adjacent to or in the site?
YES/NO.

If yes, do you know where they are located and how to identify them?

Is the site within a delineated natural area or sensitive natural area? YES/NO If so,
follow BMPs for treating weeds in the vicinity of Rare Plants (

<https://www.colorado.gov/>)

Is the site located near (<10 m) of a rare plant or within a rare plant community?

YES/NO

7. Describe actions that are being considered for this site*:

8. What are the expected results of proposed action(s)?

9. What are the potential negative impacts of proposed actions?

10. Describe the goal for the proposed action(s):

- ☐ **Eradication** (only for small populations; puncturevine, bull thistle, salt cedar)
- ☐ **Control or suppression** targeting satellite populations (Canada thistle, knapweed) (this is typically used if restoration is planned in the future or the area will be developed and removal of seed source is the goal).
- ☐ **Monitor** – get baseline to see if population is expanding – set up permanent monitoring plots

11. Describe the damage being caused by the presence of the target weed? (Is it clear the population is expanding? Should you monitor first?)

12. Will removal of the target species damage the system? And will that damage have the potential to make the system more disturbed than the existing situation (i.e., produce bare soil, impacts from equipment, herbicide residue, introduction of outside seeds, change drainage pattern, etc.)?

13. Will the removal of the target species have a high likelihood of being successful?

- a. Is there potential for re-establishment of nearby native species? YES/NO
- b. Are there on-going disturbances that may make removal of targets result in secondary invasion by non-native species? YES/NO (Is smooth brome present? herbicide residue time)
- c. Can monitoring and follow-up activities occur after treatment? YES/NO
- d. Is the size of the treatment area workable and easily monitored for sprouts and effectiveness of treatments?
- e. Proposed schedule for follow-up monitoring (within a year)

- f. Funding available for multiple follow-ups YES – NO (if No follow-up, consider no treatment)

- g. Describe how you will document success?

14. Set up photo plot or photo monitoring plot:

INITIAL BASELINE PHOTO PLOT: (set rebar and take photo that captures the site, try to return to photograph at least once a year at or near the same date (or spring and fall)).

PLOT ID: _____

UTM: _____

DATE OF

PHOTO: _____ TIME _____

DATE PLOT INITIATED: _____ # of

individuals _____ est. cover % _____

ASPECT/COMPASS HEADING FOR PHOTO:

***HERBICIDE:**

If herbicides are planned for SWMAs, a spot application technique for satellite populations may be appropriate. Follow-up monitoring and detailed information on the area treated with follow-up visits are necessary to observe whether treatments are working, and plants are not spreading. Most populations experience some sort of runoff or flooding, and many herbicides are not appropriate for natural areas (even if the species is listed on the label). Replanting may be required. If smooth brome is in the area, there is a very high probability the area will fill in with this non-native grass and reduce forb cover.

***MOWING:** Protect native landscape from mowing machinery. Mowing will likely need to occur multiple times in a growing season. Mowing is best during droughts.

Follow-up Monitoring

PLOT ID: _____

UTM: _____

DATE OF

PHOTO: _____ TIME _____

DATE PLOT INITIATED: _____ # of

individuals _____ est. cover % _____

ASPECT/COMPASS HEADING FOR PHOTO:

List actions taken in year 1 with observations:

☐ monitor

only _____

☐ satellite treatment

only _____

☐ full site treatment

Describe in detail results (population increasing/decreasing). (photo comparison – size of polygon)

Are additional treatments necessary?

Change in treatment plan for year 2?

Next Scheduled Monitoring Date: