Noxious Weed Survey of Peterson Air Force Base 2020

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COLORADO NATURAL HERITAGE PROGRAM

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CNHP's mission is to preserve the natural diversity of life by contributing the essential scientific foundation that leads to lasting conservation of Colorado's biological wealth.

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Front Cover: Top photo: Common St. Johnswort in retention basin at PAFB, Tom Baldvins, Bottom photo: Russian olive at PAFB, Tom Baldvins

EXECUTIVE SUMMARY

In the summer of 2020, the Colorado Natural Heritage Program (CNHP) mapped noxious weeds at Peterson Air Force Base (PAFB) east of Colorado Springs, Colorado. This was the third monitoring year, with 2003 the first (Anderson et al. 2003) and 2014 the second (Rondeau & Lavender-Greenwell 2014.). The project was undertaken to provide the PAFB Natural Resources Manager with information contributing to the development of a formal Integrated Weed Management Plan for all PAFB property in order to comply with the PAFB Integrated Natural Resources Management Plan, federal noxious weed laws, and Executive Order 13112. The use of repeatable data is important to facilitate comparisons of weed populations over time. This report will provide a useful tool to continue to develop and inform adaptive weed control strategies and to comply with noxious weed regulations.

Thirteen species of noxious weeds were assessed on PAFB in the summer of 2020. All 2003 and 2014 mapped weed locations were revisited with the exception of field bindweed. Field bindweed was omitted due to the widespread cover across the base, and the Colorado Noxious Weed List C status. The survey also identified new populations of noxious weeds. In 2020, four of the weeds mapped in 2003 and 2014 appear to be eradicated at this time (baby's breath, bull thistle, Dalmatian toadflax, and purple loosestrife), and three are decreasing at PAFB, reflecting an overall decline in weed cover since 2003. One new noxious weed species, common teasel, was mapped at a single location in 2020. Three species are increasing in 2020, yellow toadflax, common St. Johnswort and Canada thistle, and two are stable (bouncingbet and salt cedar). All nine extant species mapped in 2020 occupied a total of 3.6 acres, with 161 mapped locations (Table 1). Overall, the occupied acres of noxious weeds have declined at PAFB since 2003 from 10.7 (7.84 excluding field bindweed) to 3.6 acres in 2020. The number of extant features also declined from 333 (224 excluding field bindweed) in 2003, 297 (193 excluding field bindweed) in 2014 to 161 in 2020. The number of shoots has increased overall from 33,498 (15, 328 excluding field bindweed) in 2003 to 104,238 (79,195 excluding field bindweed) in 2014 to 27,670 in 2020 with the increase in yellow toadflax accounting for most of the increase.

Summary of Recommendations

- High priority species currently present in 2020 with low cover and high potential to become invasive at PAFB should be targeted for control: diffuse knapweed, common teasel, bouncingbet, salt cedar and puncturevine (Table 1).
- Continue to monitor sites with potentially eradicated species for sprouts: (Dalmatian toadflax, and purple loosestrife). Bull thistle and baby's breath have not been observed since 2003 and are likely eradicated at PAFB.
- Canada thistle and Russian olive are found in developed and manicured areas and should continue to be treated by PAFB staff to decrease the potential for these species to invade wetlands at PAFB and surrounding areas.
- Periodic base wide mapping, (e.g., once every five years), to assess management effectiveness as well as surveying for new weeds should continue.

- Consider investigating the use of available biocontrol organisms for yellow toadflax, common St. Johnswort and field bindweed.

Table 1. Summary of findings for noxious weed species monitored at the PAFB in 2020 in order of overall trend.

Trend: ? unknown decrease stable moderate increase increase; **BOLDED = Rapid Response**

Overall Trend	Scientific Name	Common Name	# Extant Features	# Shoots	Occupied Acres
?	*Convolvulus arvensis*	Field bindweed	---	---	---
	Cirsium vulgare	Bull thistle	0	0	0
	Elaeagnus angustifolia	**Russian Olive**	**33**	**80**	**1.7**
	Gypsophila paniculata	Baby's breath	0	0	0
	Linaria dalmatica	Dalmatian toadflax	0	0	0
	Lythrum salicaria	Purple loosestrife	0	0	0
	Tribulus terrestris	**Puncturevine**	**5**	**132**	**0.10**
	Centaurea diffusa	**Diffuse knapweed**	**1**	**2**	**<0.01**
	Saponaria officinalis	**Bouncingbet**	**2**	**200**	**0.01**
	Tamarix ramosissima	**Salt cedar**	**1**	**1**	**<0.01**
	Cirsium arvense	Canada thistle	104	8,651	1.3
	Hypericum perforatum	Common St. Johnswort	8	4,089	0.2
	Dipsacus fullonum	**Common teasel**	**1**	**9**	**<0.01**
	Linaria vulgaris	Yellow toadflax	6	14,506	0.3
TOTALS			**161**	**27,670**	**3.6**

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TABLE OF CONTENTS

Executive Summary i
Acknowledgements ii
Introduction 1
Methods 4
Timeline of Weed Mapping and Monitoring at PAFB 4
Results and Recommendations 5
Management Urgency Recommendations 9
Emerald Ash Borer (EAB) 11
Diffuse Knapweed (*Centaurea diffusa*) 15
Canada Thistle (*Cirsium arvense*) 18
Bull Thistle (*Cirsium vulgare*) 21
Field Bindweed (*Convolvulus arvensis*) 24
Common Teasel (*Dipsacus fullonum*) 27
Russian Olive (*Elaeagnus angustifolia*) 30
Baby's Breath (*Gypsophila paniculata*) 33
Common St. Johnswort (*Hypericum perforatum*) 36
Dalmatian Toadflax (*Linaria dalmatica*) 39
Yellow Toadflax (*Linaria vulgaris*) 42
Purple Loosestrife (*Lythrum salicaria*) 46
Bouncingbet (*Saponaria officinalis*) 49
Salt Cedar (*Tamarix ramosissima*) 52
Puncturevine (*Tribulus terrestris*) 55
References 58
Appendix A. Mapping Protocol 58

TABLE OF FIGURES

Figure 1. Distribution of known infestations at Peterson Air Force Base in 2003, 2014, and 2020 5
Figure 2. Damaged ash trees at Peterson AFB. 11
Figure 3. Examples of buffered points and lines 63

TABLE OF TABLES

Table 1. Summary of findings for noxious weed species monitored at the PAFB in 2020 in order of overall trend. ii
Table 2. Colorado Weed Ranks. 2
Table 3. Summary data for all mapped weed infestations at Peterson Air Force Base. 7
Table 4. Changes in weed distribution and abundance at Peterson AFB 2003 - 2020. 8
Table 5. List of species at PAFB in 2020 by Colorado Weed List Rank. 9
Table 6. All infestations of diffuse knapweed at PAFB. 16
Table 7. All infestations of Canada thistle at PAFB. 19
Table 8. All infestations of bull thistle at PAFB. 22
Table 9. All infestations of field bindweed at PAFB. 25
Table 10. All infestations of common teasel at PAFB. 28
Table 11. All infestations of Russian olive at PAFB. 31
Table 12. All infestations of baby's breath at PAFB. 34
Table 13. All infestations of common St. Johnswort at PAFB. 37
Table 14. All infestations of Dalmatian toadflax at PAFB. 40
Table 15. All infestations of yellow toadflax at PAFB. 43
Table 16. All infestations of purple loosestrife at PAFB. 47
Table 17. All infestations of bouncingbet at PAFB. 50
Table 18. All infestations of salt cedar at PAFB. 53
Table 19. All infestations of puncturevine at PAFB. 56

TABLE OF MAPS

Map 1. Location of Peterson Air Force Base in Colorado. 3
Map 2. Distribution of diffuse knapweed at PAFB in 2003, 2014, and 2020. 17
Map 3. Distribution of Canada thistle at PAFB in 2003, 2014, and 2020. 20
Map 4. Distribution of bull thistle at PAFB in 2003, 2014, and 2020. 23
Map 5. Distribution of field bindweed at PAFB in 2003 and 2014. 26
Map 6. Distribution of common teasel at PAFB in 2003, 2014, and 2020. 29
Map 7. Distribution of Russian olive at PAFB in 2003, 2014, and 2020. 32
Map 8. Distribution of baby's breath at PAFB in 2003, 2014, and 2020. 35
Map 9. Distribution of common St. Johnswort at PAFB in 2003, 2014, and 2020. 38
Map 10. Distribution of Dalmatian toadflax at PAFB in 2003, 2014, and 2020. 41
Map 11. Distribution of yellow toadflax at PAFB in 2003, 2014, and 2020. 45
Map 12. Distribution of purple loosestrife at PAFB in 2003, 2014, and 2020. 48
Map 13. Distribution of bouncingbet at PAFB in 2003, 2014, and 2020. 51
Map 14. Distribution of salt cedar (tamarisk) at PAFB in 2003, 2014, and 2020. 54
Map 15. Distribution of puncturevine at PAFB in 2003, 2014, and 2020. 57

INTRODUCTION

Peterson Air Force Base (PAFB) is located in El Paso County, Colorado approximately seven miles east of downtown Colorado Springs (Map 1), and lies near the ecotone of the Southern Rocky Mountain and Central Shortgrass Prairie ecoregions. The main western portion of the base is a highly developed urban area, while Peterson East is almost entirely open native grassland. Elevation ranges from 5,900 to 6,200 feet.

The weed management plan at PAFB includes goals to maintain and preserve the remnant prairie as well as comply with local weed regulations (PAFB 1996, Schuerman 1997). The management objectives are defined as specific, desired results of integrated management efforts and include the following definitions:

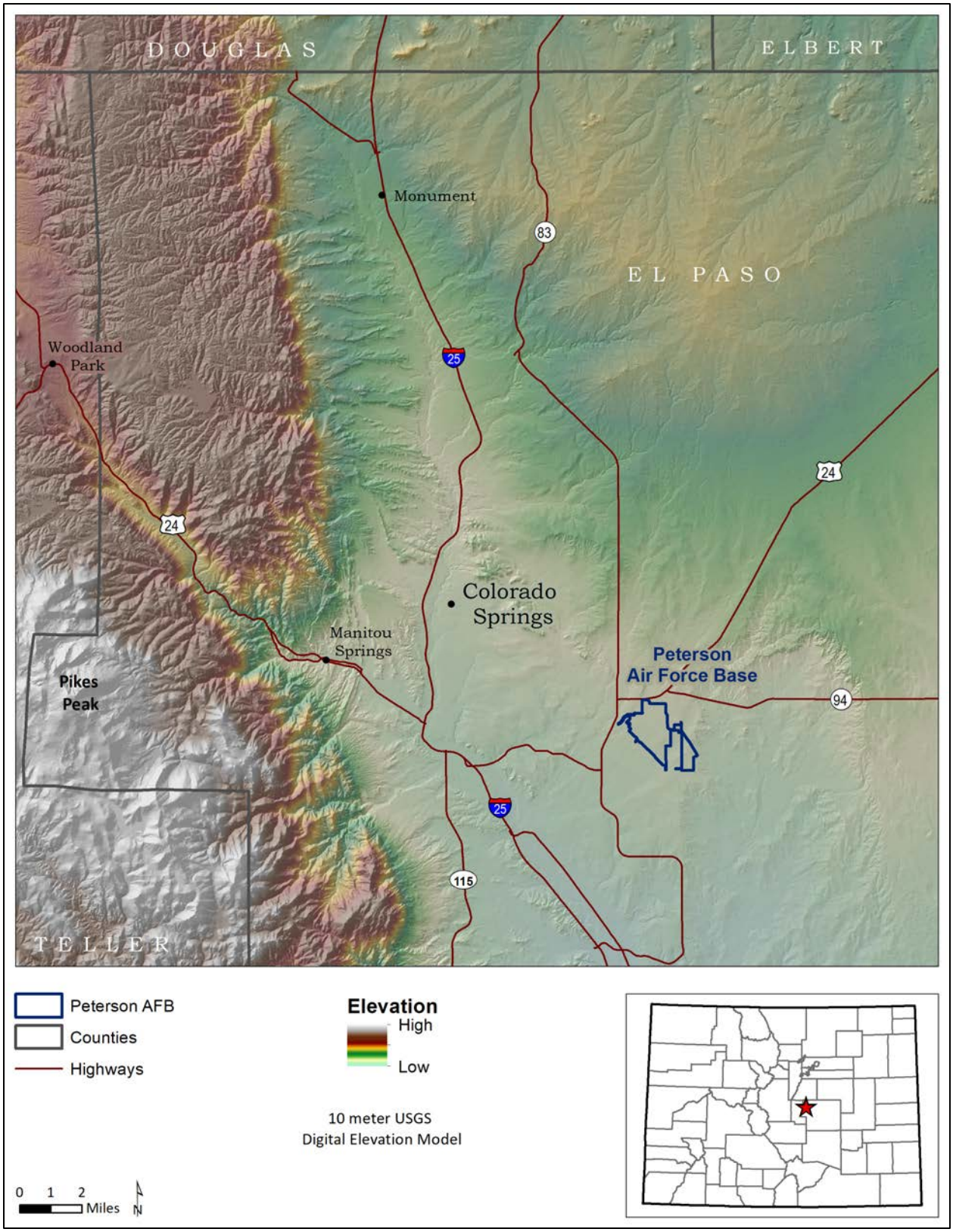
- **Eradication**: Reducing the reproductive success of a noxious weed species in a largely uninfested region to zero and permanently eliminating the species or population within a specified period of time (until the existing seed bank is exhausted).
- **Containment:** Maintaining an intensively managed 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.

The Colorado noxious weed list ranks are assigned by the Colorado Department of Agriculture 2014. List A species are typically considered to be the highest priority for management and watch list species are under consideration for listing or used for public education (Table 2). There is one List A species at PAFB which is potentially eradicated at this time, nine species are on List B, two List C and one watch list (potentially eradicated).

Table 2. Colorado Weed Ranks. Management actions are required for A-C species on these lists, as explained below (Colorado Department of Agriculture 2014).	
List A	Species in Colorado that are designated by the Commissioner for eradication.
List B	Species for which the Commissioner, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, develops and implements state noxious weed management plans designed to stop the continued spread of these species.
List C	Species for which the Commissioner, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, will develop and implement state noxious weed management plans designed to support the efforts of local governing bodies to facilitate more effective integrated weed management on private and public lands. The goal of such plans will not be to stop the continued spread of these species but to provide additional education, research, and biological control resources to jurisdictions that choose to require management of List C species.
Watch List	Species that have been determined to pose a potential threat to the agricultural productivity and environmental values of the lands of the state. The Watch List is 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.

Site Description

Most of PAFB consists of a mosaic of highly managed traditional turf shrub and tree landscaping, interspersed with lower-maintenance areas featuring swathes of rock mulch or xeric grasses and native forbs. Broad stands of irrigated bluegrass lawn are maintained along principal streets and boulevards, and around living quarters. The natural vegetation of PAFB is discernible only at the comparatively undeveloped Peterson East, and comprises mid-grass and shortgrass prairie. Mid-grass prairie remnants are difficult to distinguish, due to the mowing regime practiced to one extent or another over the entire base. Needle-and-thread appears to be the dominant grass at Peterson East and the rough at the golf course. Buffalo grass (*Buchloe dactyloides*), and to a lesser extent blue grama (*Chondrosum gracile*), are present at Peterson East and on the main part of the base, the former especially planted in areas for low maintenance. Sixweeks fescue (*Vulpia octoflora),* western wheatgrass, and Indian ricegrass (*Achnatherum hymenoides)* can also be found locally (Anderson et al. 2003).



Map 1. Location of Peterson Air Force Base in Colorado.

METHODS

Weed species mapped in 2003 and 2014 (Anderson et al. 2003, Rondeau and Lavender-Greenwell 2014) were targeted for mapping in 2020; with two noxious weeds added in 2014 and one new noxious weed species added in 2020.

Data collected in the field followed the same methods used by the Colorado Natural Heritage Program (CNHP) to map weeds at the nearby U.S. Air Force Academy, Cheyenne Mountain Air Force Station, Pueblo Chemical Depot, Buckley Air Force Base, and at PAFB in 2003 and 2014. These methods are repeatable to facilitate comparisons of weed populations throughout the years.

Basewide weed mapping in 2020 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 30 meters in any direction were mapped as polygons. Data were collected using a Trimble Yuma rugged tablet with a built-in GPS receiver (accuracy between 2-5m) and ArcPad (ESRI 1995-2018), a portable version of Geographic Information Systems (GIS) software.

Qualitative notes and actual counts and estimates for populations were made at each mapping site. When weeds were visible but exact locations were inaccessible, offsets were applied to the GPS or features were digitized heads-up using the 2019 NAIP aerial photo for reference. Notes were taken to document non-standard, "on the fly" mapping techniques. Dead weeds were noted as "dead standing" and counted as extant in the data tables since plants were alive during a recent growing season. If no signs of noxious weeds were observed at a previously infested location, the occurrence was marked as eradicated. At the request of Natural Resources staff, CNHP also mapped locations of damaged ash trees with holes to monitor for Emerald Ash Borer.

Collection of weed data at PAFB was subject to limitations imposed by human resources, time, and safety. Weather patterns and environmental phenomena also influence results. A more detailed description of the noxious weed mapping protocol is provided in Appendix A.

Timeline of Weed Mapping and Monitoring at PAFB

The Colorado Natural Heritage Program first mapped noxious weeds at PAFB in 2003 and has monitored noxious weeds in 2014 and 2020. Below is a summary of weed mapping and monitoring by year since the surveys began in 2003.

- **2003:** There were 11 species of noxious weeds monitored in 2003.
- **2014:** In addition to the 11 species monitored in 2003, there were two new species observed: diffuse knapweed and Dalmatian toadflax.
- **2020:** There were 13 species monitored including one new species, common teasel. Field bindweed was dropped from the target list due to its List C status and widespread distribution.

RESULTS AND RECOMMENDATIONS

Thirteen species of noxious weeds were assessed on PAFB in 2020. All 2003 and 2014 mapped weed locations were revisited with the exception of mapped locations of field bindweed (*Convolvulus arvensis*). Field bindweed was omitted due to the widespread cover across the base, low threat potential, and C list status. Overall, the occupied acres of noxious weeds and the number of mapped locations declined between 2003 and 2020. There were 244 extant features in 2003 (333 with field bindweed), 193 in 2014 (297 with field bindweed), and 161 extant features in 2020 (Figure 1).

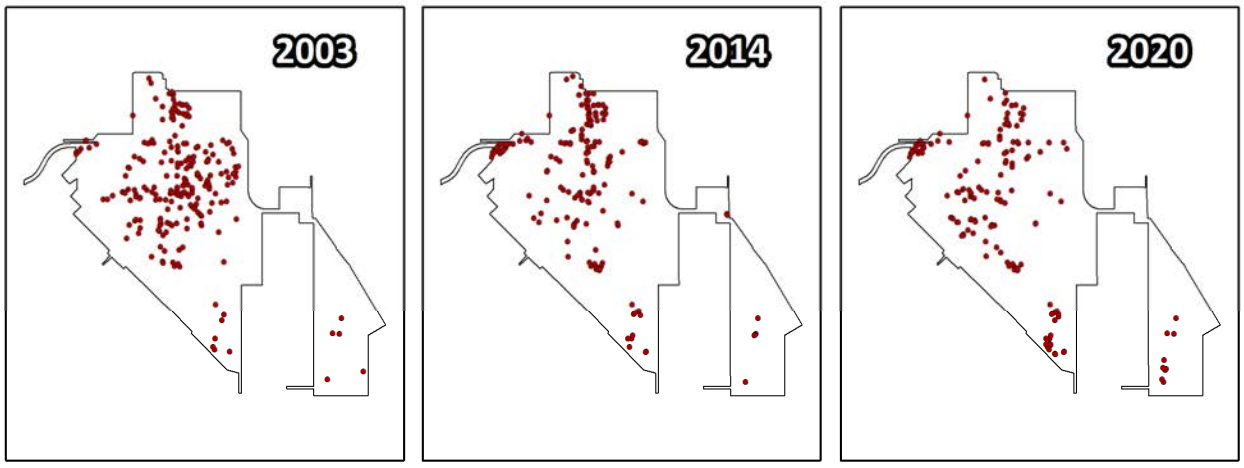


Figure 1. Distribution of known infestations at Peterson Air Force Base in 2003, 2014, and 2020 (excluding field bindweed which was not mapped in 2020). 244 extant features in 2003 → 193 extant features in 2014 → 161 extant features in 2020.

The occupied acres decreased from 10.7 (7.84 excluding field bindweed) in 2003 to 7.75 (4.97 acres excluding field bindweed) in 2014 to only 3.6 acres in 2020 (Table 3). However, the number of shoots has increased overall from 33,498 (15, 328 excluding field bindweed) in 2003 to 104,238 (79,195 excluding field bindweed) in 2014 to 27,670 in 2020 with the increase in yellow toadflax accounting for most of the increase. Three noxious weeds that are decreasing in occupied acres, number of shoots and extant features at PAFB include spotted knapweed, Russian olive and puncturevine. Bouncingbet and salt cedar have remained stable from 2003 to 2020. A new noxious weed species, common teasel, was mapped at a single location with 9 individuals. Three weed species are increasing in 2020, yellow toadflax, common St. Johnswort and Canada thistle (Table 4).

Thus, in 2020, a total of nine extant species were mapped. The occupied acres declined by 27% between 2003 and 2014 (10.7 and 7.8 acres, respectively) and declined another 27% between 2014 and 2020 (4.97 acres to 3.61, respectively, excluding field bindweed). The total number of mapped locations remained nearly stable between 2003 and 2014 (333 and 297, respectively) and decreased from 2014 to 2020 by 17% (from 193 to 161, respectively) in 2020.

Four noxious weeds mapped in 2003 and 2014 appear to be eradicated: baby's breath, bull thistle, Dalmatian toadflax, and purple loosestrife. Baby's breath has a very short seed life estimated to be only 1-2 years (DiTomaso et al. 2013). There were 16 plants mapped in 2003 and 0 in 2014 and 2020; it is likely baby's breath is eradicated at this site. However, it could be introduced at any time, as this plant is widely used in floral arrangements and may be planted in gardens. Bull thistle also has a very short seed longevity estimated to be 2-3 years (King County, 1988 and Lincoln County Noxious Weed Control Board, n.d.) and it has not been mapped since 2003 at the known locations and is likely also eradicated at this time. However, Dalmatian toadflax and purple loosestrife have much longer seed viabilities of 10 and 20 years, respectively. Both of these species have been known to sprout with large populations after years of being dormant. They are also highly invasive with the potential to cover large areas quickly. The sites where Dalmatian toadflax and purple loosestrife have been mapped should continue to be monitored.

While potentially serious noxious weeds are common at PAFB, most of those occurrences involve low cover and/or very small numbers of shoots; additionally, a number of species that are problematic at other locations are completely absent from PAFB. The presence of significant numbers of noxious weeds on property immediately adjacent to the base can only serve as a source of continual re-infestation, despite the best efforts of base personnel. Ultimately the management of noxious weeds becomes a community concern from which all derive benefit. Colorado Springs Municipal Airport faces a challenge in managing noxious weeds along Sand Creek and within the south retention basin because of the presence of water. For this reason, the noxious weeds in these two locations might be good candidates for biocontrol.

The fundamental strategy of PAFB personnel for management of noxious weeds, then, should be two-fold: 1) prevent establishment of new noxious weed species on base, and 2) simultaneously, keep the noxious weed species currently present suppressed at low numbers, or even eliminate them entirely. To accomplish this, the following management urgency recommendations are provided in the next section.

Table 3. Summary data for all mapped weed infestations at Peterson Air Force Base.

Species		2003				2014				2020			
Scientific Name	Common Name	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features	Occupied Acres	Estimated # of Shoots	# of Extant Features	# of Eradicated Features
Centaurea diffusa	diffuse knapweed	---	---	---	---	<0.01	4	2	0	<0.01	2	1	1
Cirsium arvense	Canada thistle	1.57	4,452	112	0	2.42	67,973	132	84	1.30	8,651	104	142
Cirsium vulgare	bull thistle	0.02	105	2	0	0.00	0	0	2	0.00	0	0	2
Convolvulus arvensis	field bindweed	2.84	18,170	109	0	2.78	25,043	104	49	---	---	---	---
Dipsacus fullonum	common teasel	---	---	---	---	---	---	---	---	0.01	9	1	0
Elaeagnus angustifolia	Russian olive	5.75	120	89	0	2.29	69	40	54	1.66	80	33	61
Gypsophila paniculata	baby's breath	0.05	6	4	0	0.00	0	0	4	0.00	0	0	4
Hypericum perforatum	common St. Johnswort	0.15	7,545	2	0	0.01	3	1	1	0.22	4,089	8	0
Linaria dalmatica	Dalmatian toadflax	---	---	---	---	<0.01	50	1	0	0.00	0	0	1
Linaria vulgaris	yellow toadflax	0.02	393	1	0	0.09	9,139	4	1	0.32	14,506	6	2
Lythrum salicaria	purple loosestrife	0.01	1	1	0	0.00	0	0	1	0.00	0	0	1
Saponaria officinalis	bouncingbet	0.01	201	1	0	0.01	10	4	1	0.01	200	2	3
Tamarix ramosissima	tamarisk	0.01	2	1	0	<0.01	1	1	1	<0.01	1	1	1
Tribulus terrestris	puncturevine	0.24	2,494	11	0	0.15	1,946	8	9	0.09	132	5	14
Total		**10.68**	**33,489**	**333**	**0**	**7.75**	**104,238**	**297**	**207**	**3.61**	**27,670**	**161**	**232**

Table 4. Changes in weed distribution and abundance at Peterson AFB 2003 - 2020. Positive numbers indicate an increase and negative numbers indicate a decrease. Color codes are defined as: green, < -5%; yellow, -5% to 10%; orange, 10% to 100%; red, >100%.

Scientific Name	Common Name	2020 Occupied Acres	2003 - 2014 % change	2014 - 2020 % change	Overall % Change Occupied Acres	2020 Estimated # of Shoots	2003 - 2014 % change	2014 - 2020 % Change	Overall % Change Estimated # of Shoots	2020 # of Extant Features	2003 - 2014 % change	2014 - 2020 % change	Overall % Change # of Extant Features	Overall Trend
Centaurea diffusa	diffuse knapweed	< 0.01	---	-20%	-20%	2	---	-50%	-50%	1	---	-50%	-50%	Decrease
Cirsium arvense	Canada thistle	1.30	54%	-46%	-17%	8,651	1427%	-87%	94%	104	18%	-21%	-7%	Moderate Increase
Cirsium vulgare	bull thistle	0.00	-100%	0%	-100%	0	-100%	0%	-100%	0	-100%	0%	-100%	Eradicated
Convolvulus arvensis	field bindweed	---	-2%	---	---	---	38%	---	---	---	-5%	---	---	Not Mapped 2020
Dipsacus fullonum	common teasel	0.01	---	---	---	9	---	---	---	1	---	---	---	New 2020
Elaeagnus angustifolia	Russian olive	1.66	-60%	-28%	-71%	80	-43%	16%	-33%	33	-55%	-18%	-63%	Decrease
Gypsophila paniculata	baby's breath	0.00	-100%	0%	-100%	0	-100%	0%	-100%	0	-100%	0%	-100%	Eradicated
Hypericum perforatum	common St. Johnswort	0.22	-95%	3017%	42%	4,089	-100%	136200%	-46%	8	-50%	700%	300%	Moderate Increase
Linaria dalmatica	Dalmatian toadflax	0.00	---	-100%	-100%	0	---	-100%	-100%	0	---	-100%	-100%	Eradicated
Linaria vulgaris	yellow toadflax	0.32	365%	259%	1572%	14,506	2225%	59%	3591%	6	300%	50%	500%	Increase
Lythrum salicaria	purple loosestrife	0.00	-100%	0%	-100%	0	-100%	0%	-100%	0	-100%	0%	-100%	Eradicated
Saponaria officinalis	bouncingbet	0.01	-37%	30%	-19%	200	-95%	1900%	0%	2	300%	-50%	100%	Stable
Tamarix ramosissima	salt cedar	< 0.01	-75%	0%	-75%	1	-50%	0%	-50%	1	0%	0%	0%	Stable
Tribulus terrestris	puncturevine	0.09	-38%	-40%	-62%	132	-22%	-93%	-95%	5	-27%	-38%	-55%	Decrease

Management Urgency Recommendations

Noxious weeds in Colorado are assigned to lists that indicate how these species are to be regulated with A list species considered to be the highest priority and eradication is often the management goal (see Table 2- Introduction). Only one species at PAFB is on this list, purple loosestrife. There are nine species on the B List, two on the C list and one on the watch list at PAFB (Table 5). Watch list species are known to be invasive in the state and are being considered for listing by the State of Colorado. Managing weeds at PAFB is important not only to reduce the chances of weeds invading the native grasslands on the property (or nearby) but to follow state noxious weed laws. The management priorities developed for the noxious weed species found at PAFB provided below are derived from occurrence and cover information from monitoring surveys in 2003, 2014 and 2020, as well as the biotic potential of each species and the control potential to be reasonably attainable on the base.

Table 5. List of species at PAFB in 2020 by Colorado Weed List Rank.

Management Urgency Ranks: low, medium, high, very high (eradication possible)

Management Urgency	Scientific Name	Common Name
	LIST A	
	Lythrum salicaria	**Purple loosestrife**
	LIST B	
	Cirsium vulgare	**Bull thistle**
	Linaria vulgaris	Yellow toadflax
	Cirsium arvense	Canada thistle
	Elaeagnus angustifolia	Russian olive
	Linaria dalmatica*	**Dalmatian toadflax**
	Saponaria officinalis	Bouncingbet
	Tamarix ramosissima	Salt cedar
	*Centaurea diffusa**	Diffuse knapweed
	*Dipsacus fullonum***	Common teasel
	LIST C	
	Convolvulus arvensis	Field bindweed
	Hypericum perforatum	common St. Johnswort
	Tribulus terrestris	puncturevine
	WATCH LIST	
	Gypsophila paniculata	**baby's breath**

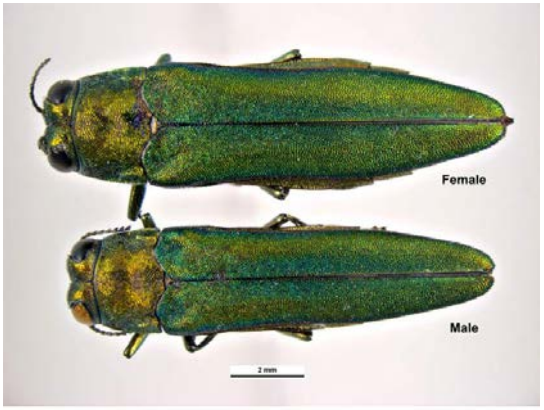
*New in 2014, **New in 2020, **POTENTIALLY ERADICATED**

Purple loosestrife would be given a very high management urgency ranking due to its List A ranking. However, as no plants were present at the original mapped site in 2020 it is a high management urgency for continued monitoring and rapid response treatment if found. Purple loosestrife escapes to wetlands and is highly invasive and difficult to treat once established. Of the nine B List species, two have been assigned a very high management rank, common teasel and diffuse knapweed. These two species are difficult to control once established and currently at PAFB both species can be eradicated if it is treated right away. Six species, Canada thistle, Dalmatian toadflax, Russian olive, bouncingbet, puncturevine and salt cedar, are given high management priorities. Dalmatian toadflax was not present in 2020 but has the potential to occur at the known locations due to long seed viability and has been known to sprout with large numbers of individuals in a single season if the conditions are right. Dalmatian toadflax is difficult to treat once established, and monitoring the known locations should be a high priority. Canada thistle is largely found in manicured areas and development. There is a risk the seeds can spread to surrounding wetlands where this species is known to become highly invasive. Continued efforts to control Canada thistle should be a high priority. Salt cedar has been present for many years but currently there is only one location with one individual that can be controlled. Wetlands adjacent to PAFB contain salt cedar and efforts to keep this species from becoming established at PAFB should be a high priority due to its potential to become invasive in wetlands and riparian areas. Bouncingbet and Russian olive are introduced ornamental plants that are known to escape to natural areas and wetlands where they can become invasive. Bouncingbet is only known from two locations with about 200 individuals. At this stage it has a high probability for eradication and therefore, should be a high priority for control. Russian olive is being treated successfully with reductions noted since 2003. Continued control efforts should be a high priority for Russian olive. Puncturevine is very easy to control compared to many other noxious weed species and efforts by PAFB have resulted in reduced cover. Currently, there are only 132 individuals at five known sites which should be a high priority for treatment and continued monitoring as eradication is likely. Bull thistle and baby's breath are given low management priorities as they have not been mapped since 2003, in addition to their relatively short seed longevities of just 1-3 years.

Two species of noxious weeds are too widespread to map or treat efficiently and they include field bindweed, yellow toadflax. A third species, common St. Johnswort is located in a highly disturbed system with other weeds. All three of these species are on List C and are currently assigned a low management urgency. Biocontrol organisms are available and could be considered for all three of these species.

Emerald Ash Borer (EAB)

At the request of Natural Resources staff, CNHP also mapped locations of damaged ash trees with holes to monitor for Emerald Ash Borer. The emerald ash borer (*Agrilus planipennis*) beetle, known as EAB, targets and kills ash trees and could be present at the PAFB; however, it was not observed in 2020. CNHP contacted the El Paso County extension to see if EAB has been observed the county, and so far there have been no confirmed reports from the county (pers. Comm. Irene Shonley April 12, 2021).



USA. Michigan State University, East Lansing Michigan, June 2008, Judy King, reared ex Fraxinus logs det. J King 2008

Ken Walker Museum Victoria

https://ag.colorado.gov/eab-identification-and-reporting

EAB only kills species in the Genus *Fraxinus* and does not harm Mountain ash trees, in the Genus *Sorbus*. Both of these species are planted widely in residential areas. EAB is native to Eastern Russian and Northeastern China (Haack et al. 2002) and was first observed in Michigan in 2002 where it has since spread to 35 states. Efforts to quarantine EAB across the U.S. have been ineffective (APHIS USDA 2021). In Colorado, EAB has been found in Boulder, Larimer and Broomfield counties (https://ag.colorado.gov/plants/emerald-ash-borer).

In Colorado, our most common ash species is green ash (*Fraxinus pennsylvanica*). This species is considered both native and introduced, depending on where it is found in Colorado. Green ash has been commonly planted along the Front Range in residential areas and cities for decades. However, green ash is considered native along floodplains of rivers or along the margins of lakes on the eastern plains (Ackerfield 2015). The Department of Agriculture is releasing four species of singles wasps that appear to target EAB as a means of biocontrol. There are chemical methods that can protect trees, but they are typically used for trees that are of special importance due to the expense, yearly application and toxicity of the

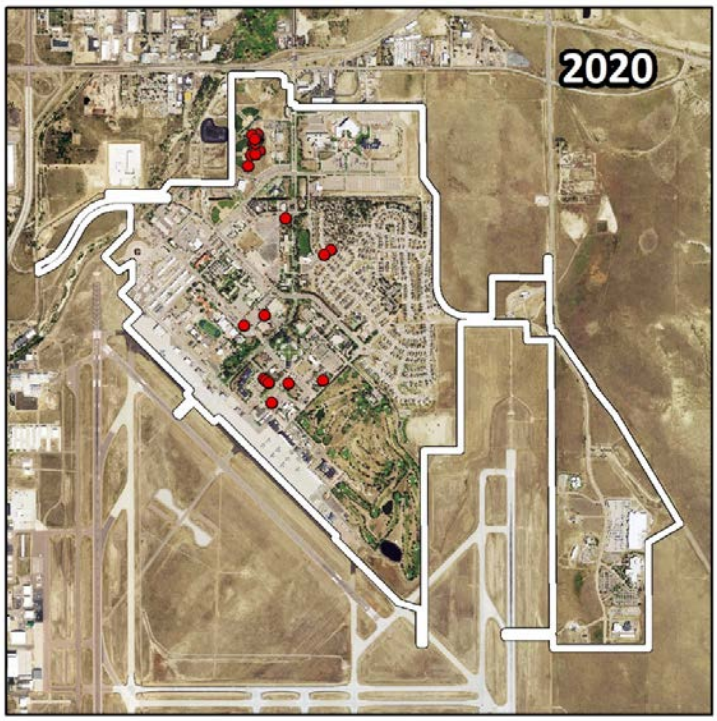


Figure 2. Damaged ash trees at Peterson AFB.

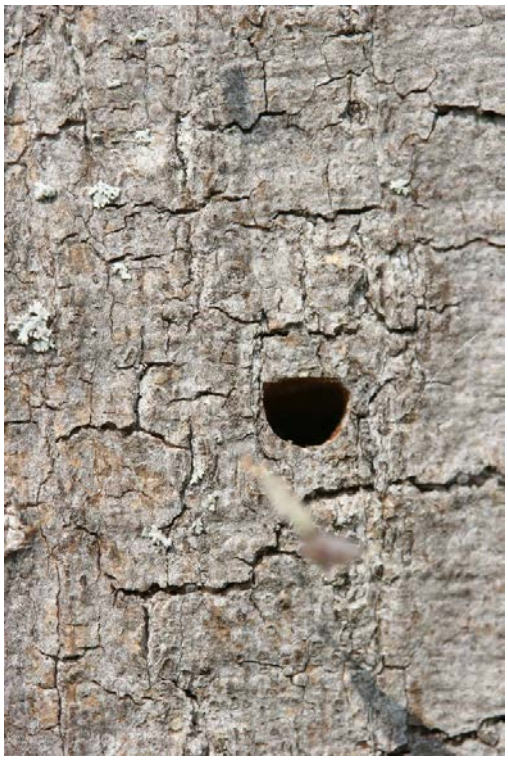
chemical treatments (APHIS USDA). In cities, many of the green ash trees are being removed and replaced with other species of trees as a means to reduce EAB populations.

CNHP found several ash trees with burrow holes during the 2020 survey (Figure 2) and submitted 12 photos of these trees to Dave Leatherman, a retired State of Colorado Entomologist, to determine if EAB is present. All of these trees were found along developed areas such as parking lots and maintained lawns (Photos 1-3).

Photos 1-3. of insect holes in green ash at PAFB. Photos: Tom Baldvins 2020.

David Leatherman's conclusions after viewing the photos at PAFB are that they are not EAB. They are other species of borers in a different family of insects known as the Cerambycidae. The most likely candidate is a banded ash borer (*Neoclytus caprea*) or the Red-headed ash borer (*N. acuminatus*). They are common in our area, make holes that are best described as "oval" shaped (not flat on one side or "D-shaped"). The activity of these borers often gets mistaken for EAB and is probably involved in a lot of the ash branch/trunk failures that occurred during the recent big snow storm. Another insect, the Flatheaded Apple Tree Borer, in the same family Buprestidae as EAB, is also common in our area. It has a broad deciduous tree host range, including ash. Its tunnels are flat-sided and also get confused with those of EAB. EAB photos taken in Michigan and Ohio of tunnels and holes (Photos 4-8) are provided for comparison.

Photo 4. Example of an EAB bark crack and exit hole from ash tree in Ohio/Michigan. Photo D. Leatherman



Photos 5 & 6. EAB D-shaped exit holes from ash trees from Ohio/Michigan. Photo: David Leatherman

Photos 7 & 8. EAB galleries (tunnels) from ash trees in Ohio/Michigan. Photos: David Leatherman

Diffuse Knapweed (*Centaurea diffusa*)

Overall Trend: Decreasing

Management Goals: Eradication

LIST B

Photos: Top left: diffuse knapweed plant. Top right: diffuse knapweed mature flower. Flowers can be white or pink. Photos Wikimedia.

Bottom left: rosette of diffuse knapweed. Photo North Dakota State University 2018.

- Short-lived non-creeping perennial, biennial, or annual that spreads only by seeds.
- Seeds germinate anytime during the growing season with disturbance.
- Seed longevity of 7-10 years (CCR 2014) – wind dispersed.
- Provides nectar and pollen for honeybees.
- Highly competitive, rapid growth rate, long growing season and prolific seed production.
- Plant has tumbleweed mobility.
- Forms rosettes in its early growth stage (1-2 years).
- Can sprout from the root crown after top-kill (Zouhar 2001).

2020 Results

Diffuse knapweed is declining at PAFB. One occurrence of diffuse knapweed was found at PAFB in 2020 with two shoots. In 2014, there were two known locations with four shoots. Diffuse knapweed was not present in 2003 (Table 6, Map 2).

Table 6. All infestations of diffuse knapweed at PAFB.

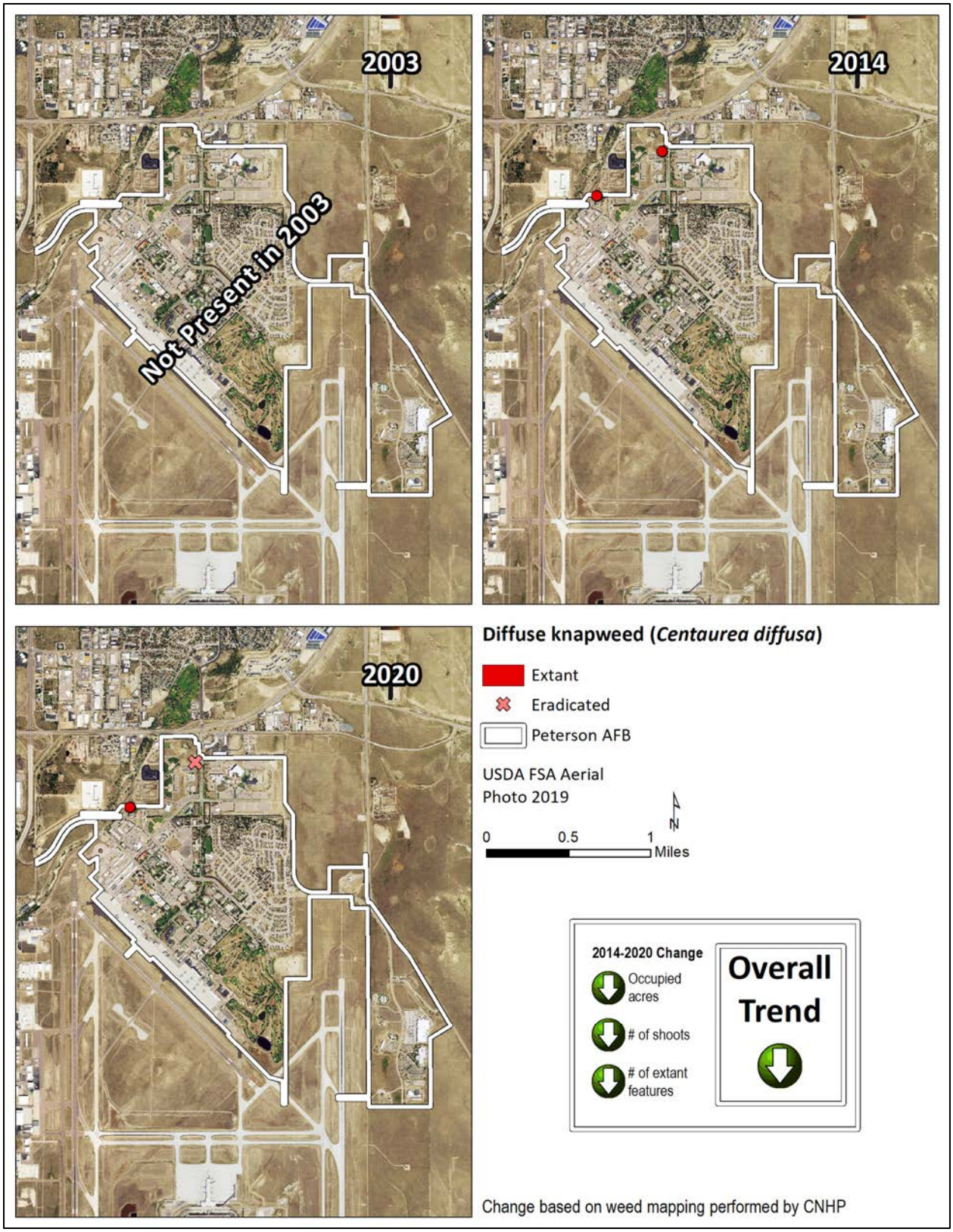
	Occupied Area (Square Meters)	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2003				
2014	16 m^2	4	2	0
2020	13 m^2	2	1	1

Recommendations

Monitor both the extant and eradication locations of diffuse knapweed (Map 2) at least once per year early in the growing season and remove plants while still in the rosette stage to prevent seeds from being produced. A photo of the rosettes is provided above. Although the current cover is really low, this species should be considered a very high priority for rapid response due to the potential for this species to become a serious problem very quickly. Sprouts may continue to be found at these sites for 7 to 10 years due to the viability of the seeds in the soil. Preventing seed set and reducing soil disturbances is the most important action to eradicate diffuse knapweed at PAFB at this time.

Monitoring History:

- Diffuse knapweed was first discovered at PAFB in 2014 with four shoots at two different locations; one near the north entrance station and the other one near the east entrance station.
- In 2020, only one location was found with two shoots.



Map 2. Distribution of diffuse knapweed at PAFB in 2003, 2014, and 2020.

Canada Thistle (*Cirsium arvense*)

Overall Trend: Moderately Increasing

Management Goals: Suppression/Containment

LIST B

Photos: Left: mature Canada thistle plant, NDSU. Upper right: Canada thistle rosettes, Oregon State University. Lower right: Canada thistle in seed by Jill Handwerk (CNHP), 2014.

- Perennial.
- Small, marble-sized flowering heads; male and female plants separate.
- Horizontal and vertical roots > 10 feet deep; stimulated by above ground treatments.
- Reproduction from root buds and seeds, 15,000 seeds per stem (Price 2018).
- Seed longevity 22 years with deep burial promoting longevity (CSU 2013a).
- Susceptible to shading and inundation.

2020 Results

Canada thistle populations at PAFB have fluctuated widely between 2003 to 2020 and declined since 2014. In 2020, the 8,651 shoots mapped are almost twice the number found in 2003 even though the occupied acres are slightly lower than 2003 (Table 7, Map 3). Therefore, it is considered to be moderately increasing at this time.

Table 7. All infestations of Canada thistle at PAFB.

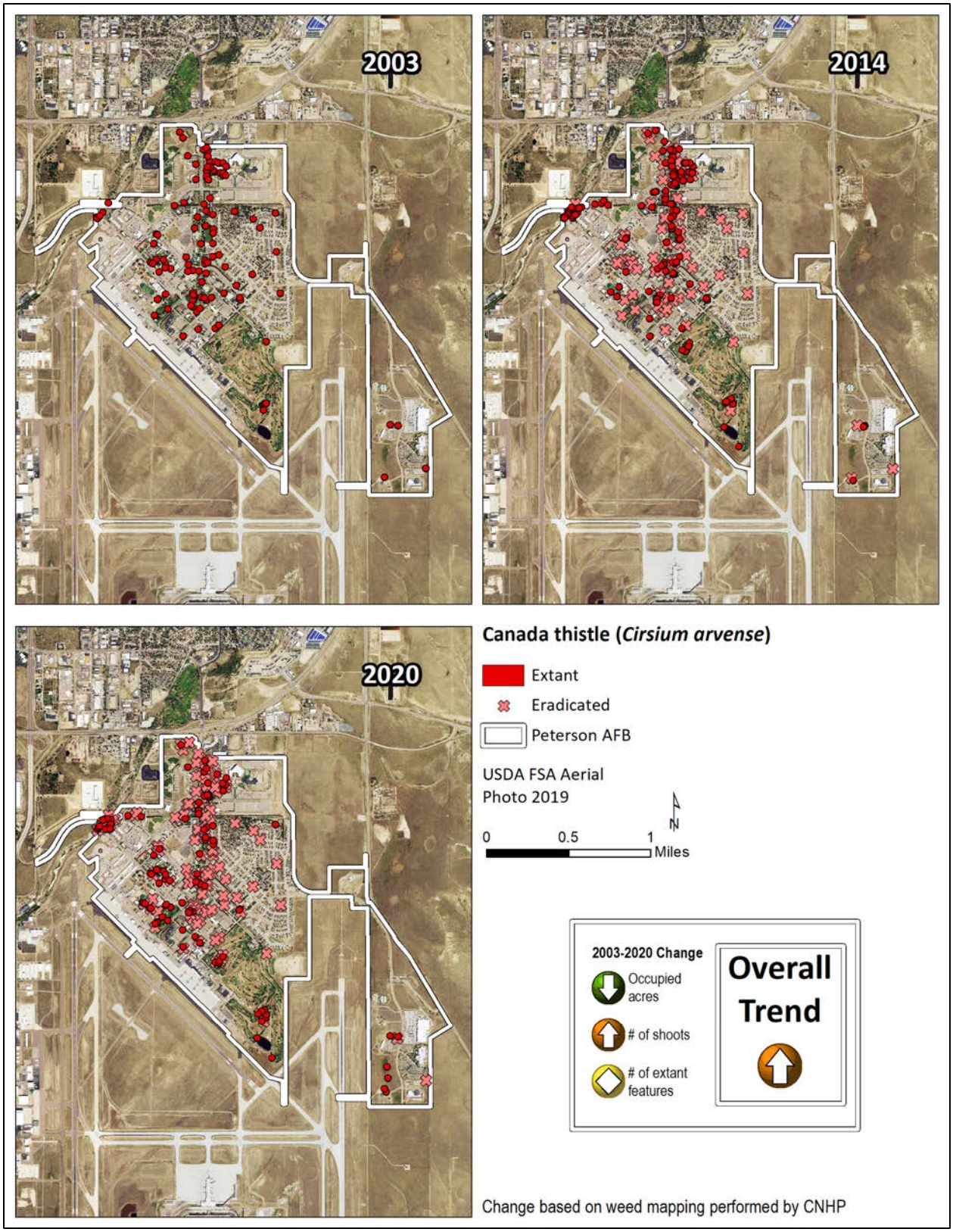
	Occupied Area (Acres)	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2003	1.6	4,452	112	---
2014	2.4	67,973	132	84
2020	1.3	8,651	104	142

Recommendations

The majority of the Canada thistle sites occur within managed areas including mowed lawns and mulched garden beds. The fluctuations are most likely related to gardening and management activities that are occurring within residential and other developed areas at PAFB. Canada thistle can enter natural systems, especially wetlands and riparian corridors where it can become a dominant. Preventing seeds from getting into more natural areas at PAFB should be a high priority by continuing to treat existing populations in more manicured areas to contain and suppress the existing populations at PAFB.

Monitoring History:

- In 2003, Canada thistle was mapped at 112 extant features at PAFB.
- In 2014, the extant features increased by 20 sites to a total of 132 locations. The number of shoots increased more than tenfold from 4,452 to 67,973.
- In 2020, there were 104 extant occurrences and 8,651 shoots indicating a dramatic decrease from 2014, yet double what was mapped in 2003. Plants are confined to developed areas.



Map 3. Distribution of Canada thistle at PAFB in 2003, 2014, and 2020.

Bull Thistle (*Cirsium vulgare*)

Overall Trend: Eradicated

Management Goals: Monitor for New Occurrences

LIST B

Photo: mature bull thistle in flower, kingcounty.gov

Photo: Top: bull thistle first year rosette, kingcounty.gov; Bottom: bull thistle flower with notable spines, wikimedia.org

- Branching, biennial to short-lived perennial
- Sharp spines on leaf edges and stems.
- Reproduction only by seed.
- Seed longevity of 3 years with up to 4,000 seeds per plant (King County 1988).
- Short fleshy taproot with many primary roots.
- No rhizomes.

2020 Results

There were no bull thistle plants observed at the two known sites originally mapped in 2003. Plants were not found in 2014 or 2020 at PAFB (Table 8, Map 4). Since it has been over 17 years since the plants have been observed and the seed longevity is only three years, bull thistle is likely eradicated from the base.

Table 8. All infestations of bull thistle at PAFB.

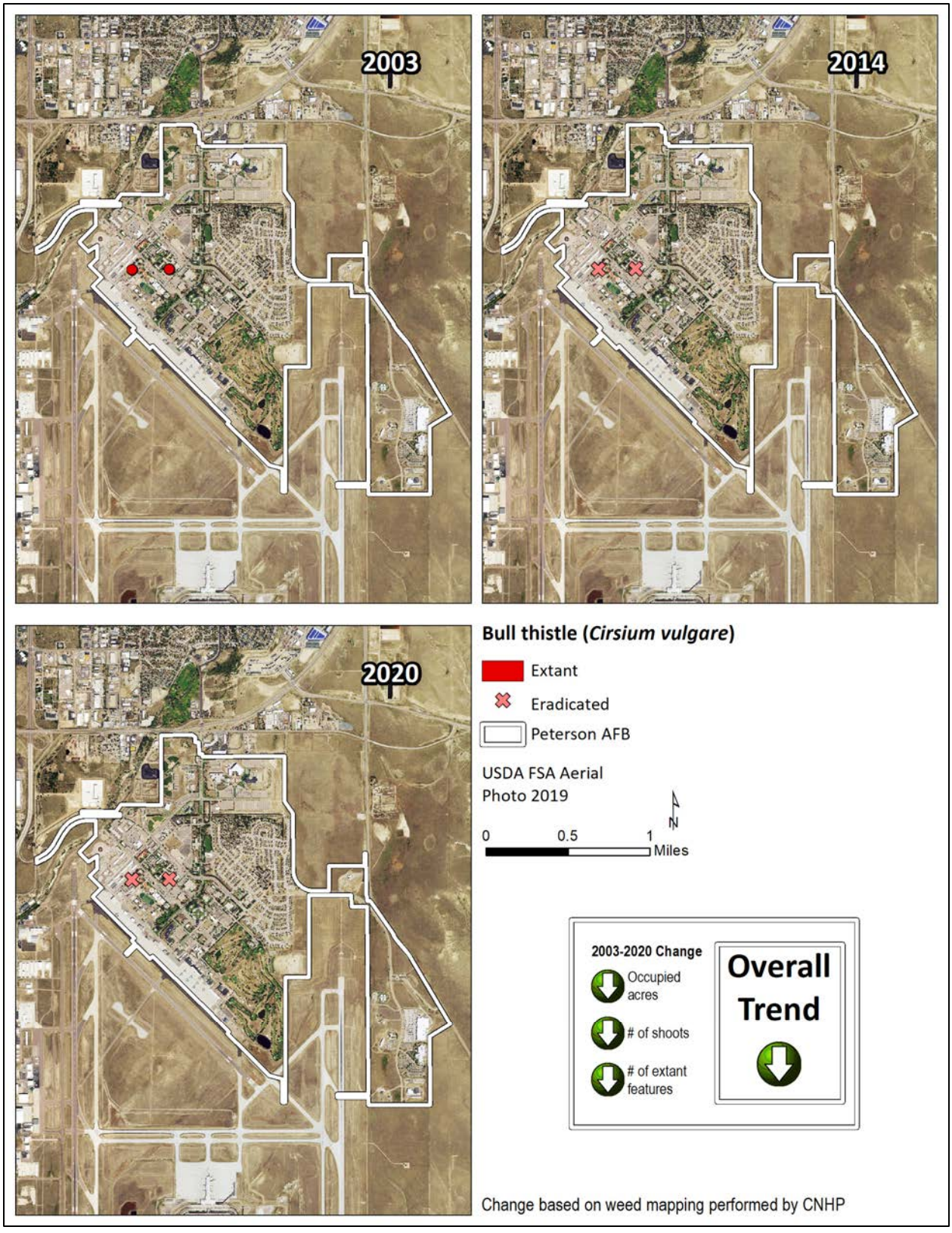
	Occupied Area (Square Meters)	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2003	100 m^2	105	2	0
2014	0	0	0	2
2020	0	0	0	2

Recommendations

Bull thistle is one of the easiest thistle species to control. The two known sites have not had any new plants in over 17 years. It should stay on the list of potential species that could occur at PAFB but the threat level is very low at this time. Rapid response, if new plants are found, would include cutting the root four inches below the soil surface (or remove completely) and monitor the site for at least three years following removal.

Monitoring History:

- In 2003, 105 shoots were found at two separate locations covering 100 square meters at PAFB.
- In 2014, no shoots were found at the two known locations.
- In 2020, no shoots were found at the two known locations. Bull thistle appears to be eradicated at PAFB.



Map 4. Distribution of bull thistle at PAFB in 2003, 2014, and 2020.

Field Bindweed (*Convolvulus arvensis*)

?

Overall Trend: Widespread (not mapped in 2020)

Management Goals: Prevention

LIST C

Field bindweed in flower.
https://en.wikipedia.org/wiki/Convolvulus_arvensis

Photo: Field bindweed flower, Michigan State University
http//www.pestid.msu.eduwp-contentuploads201412Field-bindweed-flower.jpg

- Perennial climbing herbaceous vine with roots 2 to 10 feet deep
- Colony forming
- Reproduction by seed and spreading roots
- Seed viability is extremely long, up to 50 years (WSU Extension 2021)
- Resistant to many control methods
- Plant increases are often correlated with higher precipitation

2020 Results

In 2020, field bindweed was not mapped due to its List C status and widespread cover across the base. There were large numbers of occurrences in previous weed surveys in 2003 and 2014 (Table 9, Map 5).

Table 9. All infestations of field bindweed at PAFB.				
	Occupied Area (Acres)	**Estimated Number of Shoots**	**Number of Extant Features**	**Number of Eradicated Features**
2003	2.8	18,170	109	49
2014	2.8	25,043	104	
2020*				

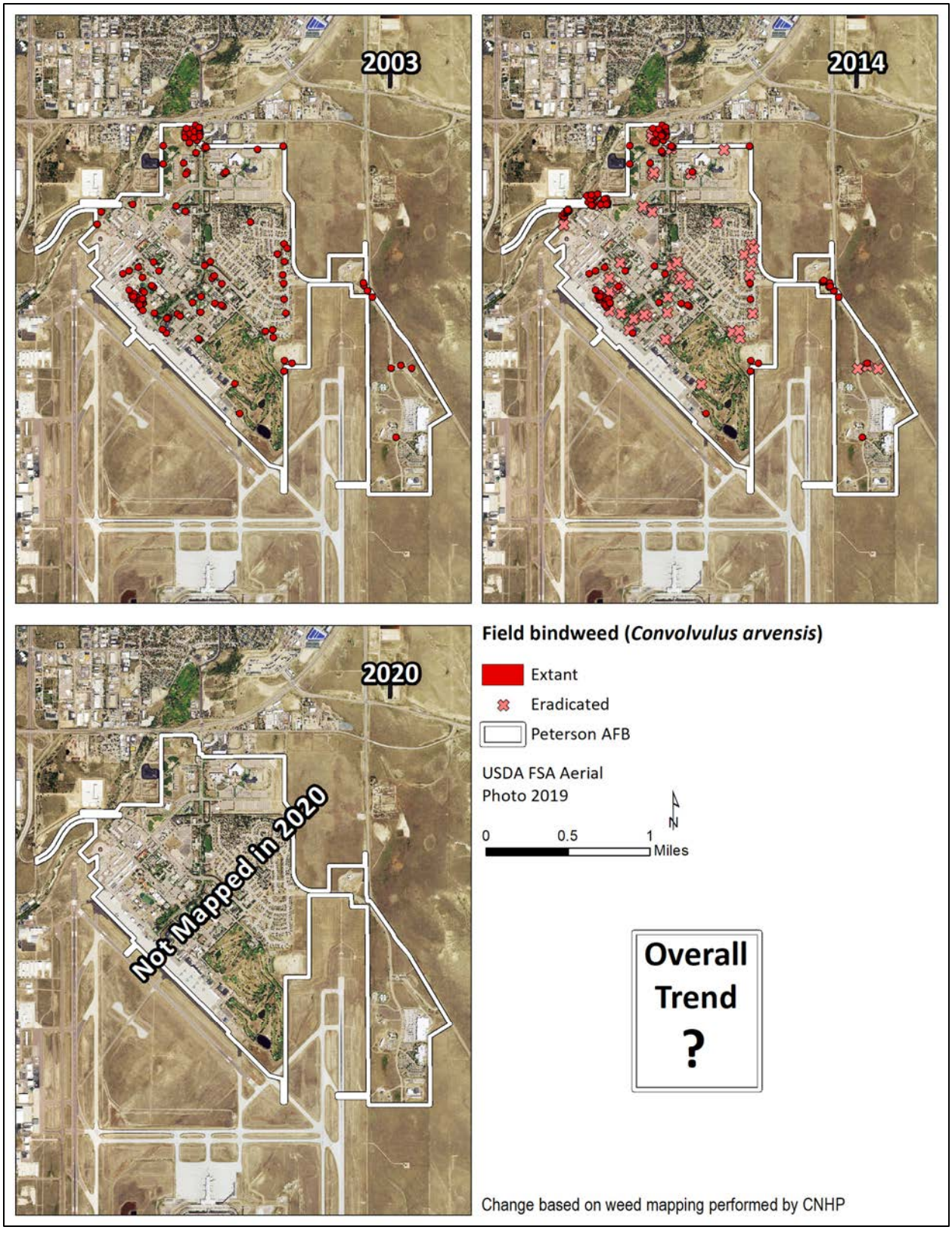
*Not mapped in 2020.

Recommendations

Once a noxious weed species reaches a cover in excess of an acre across a landscape, eradication is not typically feasible. If this species is not causing problems, we do not recommend treatment. However, if treatment is necessary, biocontrol organisms have been successful in some instances in reducing the cover of field bindweed.

Monitoring History:

- In 2003, there were 109 mapped extant locations contain 18, 170 shoots covering 2.8 acres.
- In 2014, there were 104 mapped extant locations with 25,043 shoots covering 2.8 acres.
- In 2020, field bindweed was not mapped due to the widespread nature, its List C noxious weed status, and difficulty in treating.



Map 5. Distribution of field bindweed at PAFB in 2003 and 2014.

Common Teasel (*Dipsacus fullonum*)

Overall Trend: Increasing- NEW in 2020

Management Goals: Eradication

LIST B

Above photo: mature common teasel, wikimedia.org

Above photos, wikimedia.org: top left: flowering head; top right: first year rosette; bottom photo: mature common teasel stands can become very dense, kingcounty.gov

- Biennial, sometimes monocarpic perennial forb that can grow over six feet tall.
- Reproduction solely from seed; seed viability is two years (King County 2018).
- Up to 34,000 seeds per plant (King County 2018).
- Basal foliage is prickly, lilac colored flowers in a spiral around the egg-shaped, spiny heads.
- Seeds fall near the plant but often moved by water, mowers, soil movement and animals.
- Deep taproot up to 2 feet long.

2020 Results

Common teasel was discovered during the noxious weed survey in 2020. It was found at a single site in the northwest with nine shoots occupying 28 square meters (Table 10, Map 6).

Table 10. All infestations of common teasel at PAFB.

	Occupied Area (Square Meters)	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2003	---	---	---	---
2014	---	---	---	---
2020	28 m^2	9	1	0

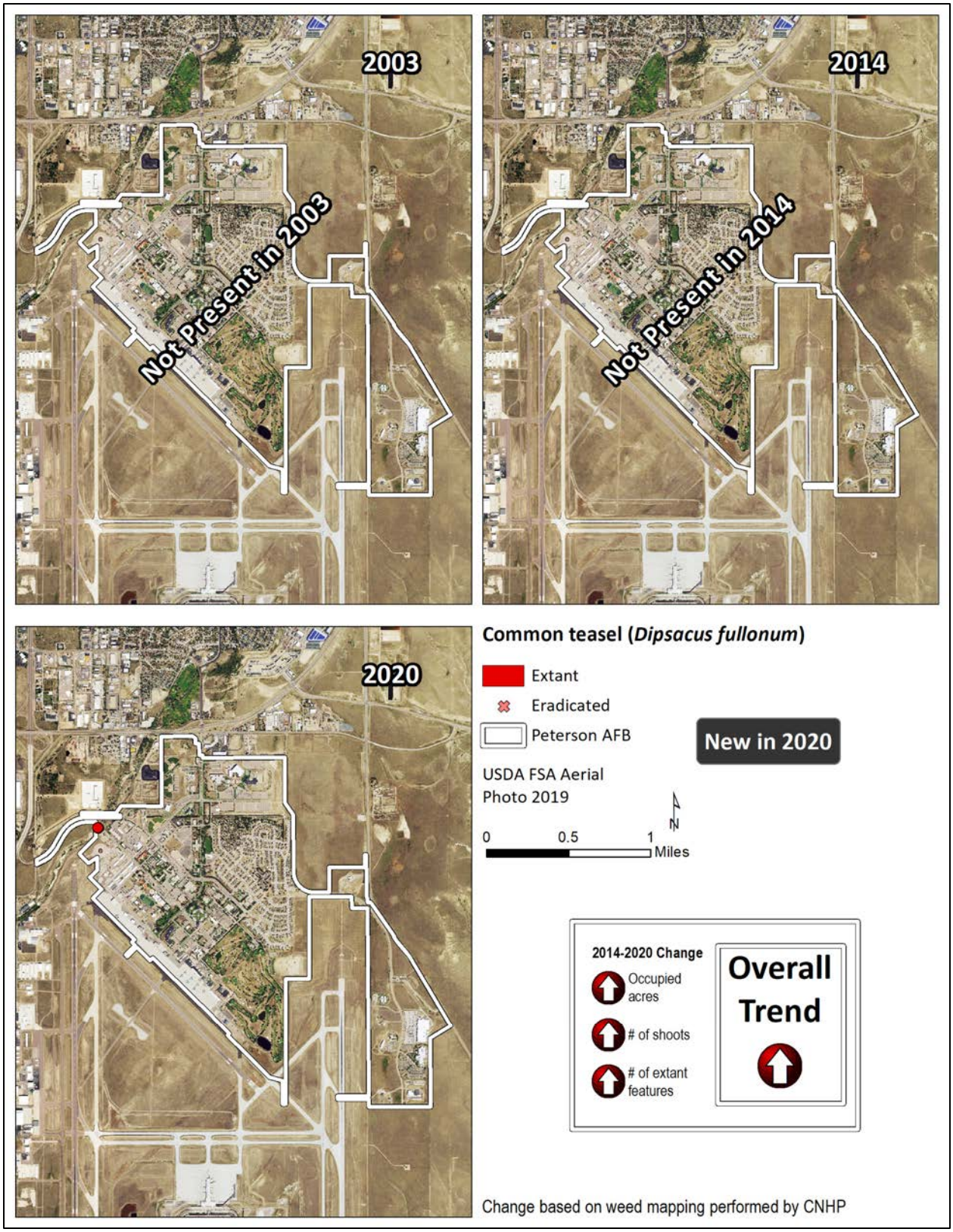
Recommendations

This plant should be easy to control at this stage if appropriate actions are taken. A high priority should be placed on monitoring this site at least once a season and more if plants are found and treated. Common teasel is highly invasive and very hard to eradicate once it becomes established.

Plants grow as rosettes for one or more years (monocarpic perennials) until resources are built up enough to flower and set seeds. Reproduction is entirely from seed, producing up to 34,000 seeds per plant. Although most seeds fall near the parent plant, they can also be transported by mowing, water, soil movement and animals. Since the taproots can grow to two feet long, we recommend severing the root below the soil surface (below the root crown). This is a good way to remove the plants while minimizing the soil disturbance. Any flowering or fruiting heads need to be bagged and transported to a disposal site. It is always best to remove plants before they bolt and go to seed. Monitoring of this site should continue for at least three years as the seed viability is estimated to be two years.

Monitoring History:

- In 2020, common teasel is a new discovery at PAFB, found at a single site with nine individuals (King County 2018).



Map 6. Distribution of common teasel at PAFB in 2003, 2014, and 2020.

Russian Olive (*Elaeagnus angustifolia*)

Overall Trend: Decreasing

Management Goals: Suppression /Eradication

LIST B

- Ability to establish in the absence of disturbance (Montana Audubon 2010).
- Seeds are largely dispersed by birds and mammals.
- Can enhance wildlife in disturbed environments where native species have been removed.
- May or may not rapidly spread depending on site characteristics.
- Injured, treated trees sprout.
- Difficult to control once established.
- Nitrogen-fixing capabilities.
- Intentional planting in the U.S. since the early 1900's until recently.

2020 Results

In 2020, there were 80 individuals at 33 extant features, occupying 1.7 acres. Russian olive has been declining since it was first mapped in 2003. Although, it is distributed across PAFB, many trees are located in residential areas (Table 11, Map 7).

Table 11. All infestations of Russian olive at PAFB.

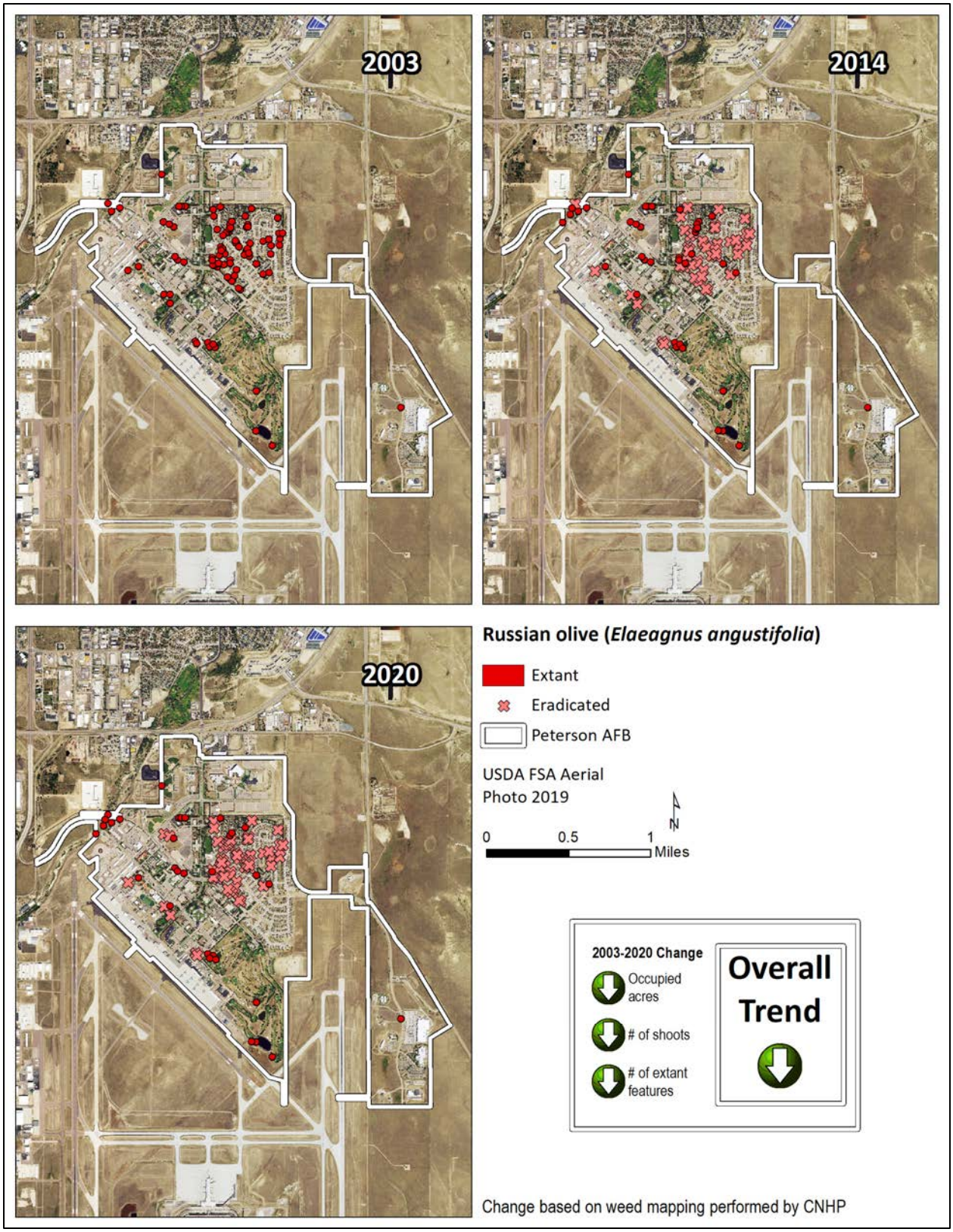
	Occupied Area (Acres)	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2003	5.7	120	89	---
2014	2.3	69	40	54
2020	1.7	80	33	61

Recommendations

PAFB personnel have been removing trees resulting in a continuous decline in the number of mapped features since 2003. With continued effort by PAFB, this species could be eliminated or greatly reduced over the next few years.

Monitoring History:

- In 2003, there were 89 extant features with 120 individuals occupying 5.7 acres.
- In 2014, there were 69 extant features with 69 individuals occupying 2.3 acres.
- In 2020, there were 33 extant features with 80 individuals occupying 1.7 acres.



Map 7. Distribution of Russian olive at PAFB in 2003, 2014, and 2020.

Baby's Breath (*Gypsophila paniculata*)

Overall Trend: Eradicated

Management Goals: Yearly Monitoring of Eradicated Sites

Watch List

Left: mature common baby's breath, wikimedia.org

Right: Common baby's breath flowers, wikimedia.org

- Escaped ornamental plant with numerous, small white flowers.
- Plants break off at ground level and tumble with the wind spreading seeds.
- Reproduction solely from seed with up to 14,000 seeds per plant (DiTomaso et al. 2013).
- Seeds survive 1 or 2 years and require little to no dormancy period (DiTomaso et al. 2013).
- Regrows after mowing.
- Large deep-tap rooted perennial species. Roots can penetrate soils to depths of 13 feet (DiTomaso et al. 2013).
- Seeds are small and black resembling black pepper, and can germinate in 10 to 15 days.
- Plants are difficult to remove once established and can produce millions of seeds in a small area.

2020 Results

In 2020, baby's breath was not found at the four previously mapped locations with six individuals removed. It has not been observed since the 2003 noxious weed survey at PAFB (Table 12, Map 8).

Table 12. All infestations of baby's breath at PAFB.

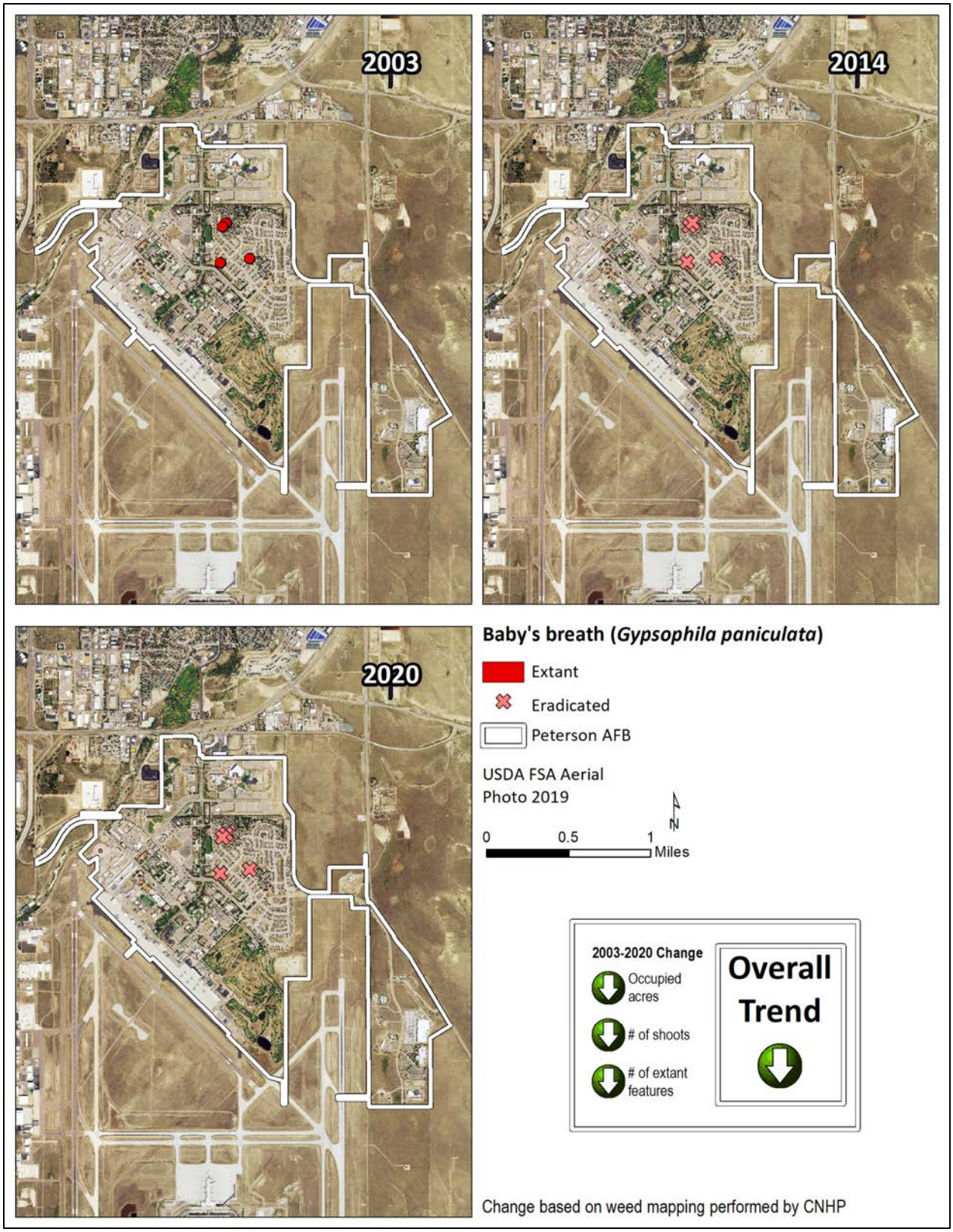
	Occupied Area (Square Meters)	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2003	201 m^2	6	4	0
2014	0	0	0	4
2020	0	0	0	4

Recommendations

While this species appears to be eradicated from the base, we recommend that management add this to a watch list for PAFB weeds. The seed longevity is very short and these plants are most likely eradicated. However, they are easily introduced when floral arrangements are discarded or when baby's breath is grown as an ornamental in gardens and escapes into natural areas where it can become invasive.

Monitoring History:

- In 2003, there were six individuals at four locations.
- In 2014, no baby's breath plants were found at PAFB and it is thought to be eradicated.
- In 2020, no baby's breath plants were found at PAFB and is apparently eradicated.



Map 8. Distribution of baby's breath at PAFB in 2003, 2014, and 2020.

Common St. Johnswort (*Hypericum perforatum*)

Overall Trend: Moderately Increasing

Management Goals: Suppression

List C

- Perennial forb
- Early successional stage
- Invades disturbed areas
- Can produce fertile seeds without pollination
- Reproduction by seed and sprouts from lateral roots and crowns
- Grows in dry and wet areas in PMJM habitat
- Seeds viable in seed bank 20+ years

Photo by Renee Rondeau, CNHP

Photo by Michelle Washebek, CNHP

2020 Results

In 2020, common St. Johnswort is considered to be moderately increasing with 4,089 individuals (shoots) found at eight locations. In 2003, there were almost double the number of shoots which were treated and only three shoots at a single site were observed in 2014. In 2020, six new mapped features were mapped (Table 13, Map 9).

Table 13. All infestations of common St. Johnswort at PAFB.

	Occupied Area (Square Meters)	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2003	622 m^2	7,545	2	---
2014	28 m^2	3	1	1
2020	881 m^2	4,089	8	0

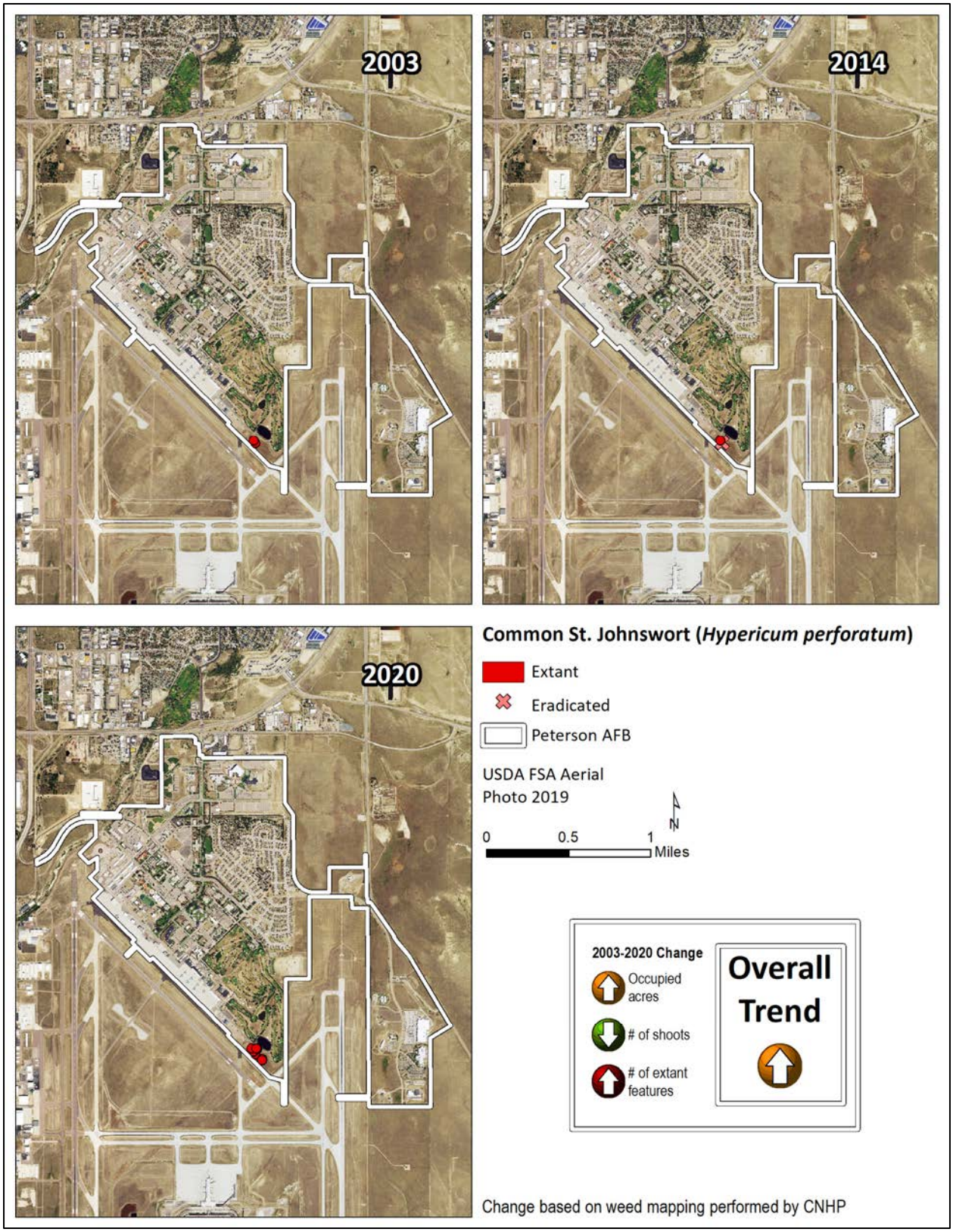
Recommendations

All known locations of common St. Johnswort are found in or near a water retention area between an airport runway and a golf course. The disturbances from these types of land uses promote weeds due to a variety of disturbances including pollution from runoff from the surrounding developed area. Removing weeds in areas that only support weeds is not recommended. Even with a restoration plan, it will likely be very difficult to establish native plant species. In this case, the weeds may be providing some remediation for the area by filtering pollutants. Rather focus attention on looking for, and controlling new smaller populations as they are found across the base. Mechanical treatments can be effective with small populations. Plants can sprout from roots if they are not all removed and follow-up monitoring is important to get sprouts that may result from incomplete removal or seeds, which can be viable for many years in the soil.

Biocontrol is available for common St. Johnswort and may be useful to provide some control and reduce seed production. The beetles used for biocontrols will not typically eradicate the target species (which is true of most types of biocontrols), they weaken the plants thus providing some control. Biocontrol organisms are available through the Palisades Insectary in Colorado (https://visitpalisade.com/portfolio-item/palisade-insectary/).

Monitoring History:

- In 2003, there were 7,545 individuals at two extant features occupying 622 square meters.
- In 2014, there were only 3 individuals at one extant feature occupying 28 square meters.
- In 2020, there were 4,089 individuals mapped at eight extant features occupying 881 square meters.



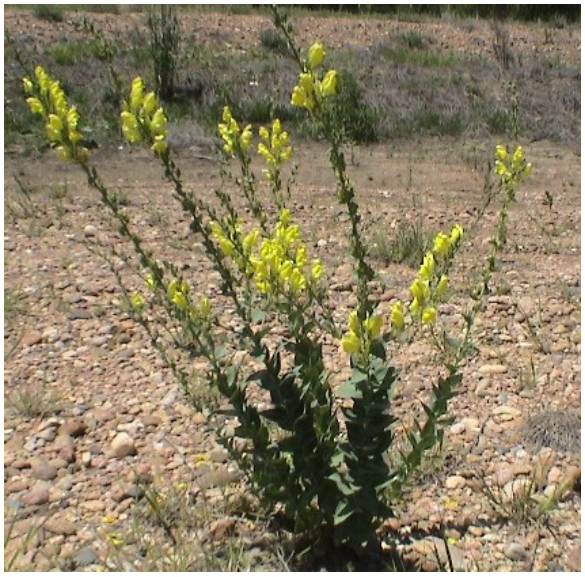
Map 9. Distribution of common St. Johnswort at PAFB in 2003, 2014, and 2020.

Dalmatian Toadflax (*Linaria dalmatica*)

Overall Trend: Eradicated

Management Goals: Yearly Monitoring at Eradicated Sites

State List: B



Photos: Colorado State University

- Perennial garden escape
- Emergence early spring, flowers May-June
- Reproduction by seeds and root buds
- Extensive root systems in established populations
- Seed production estimated at 50,000 per plant
- Seed longevity is estimated at 10 years (CDA-CSU 2015)
- Difficult to control once established

2020 Results

There was one extant location in 2014 but no Dalmatian toadflax plants were found in 2020 at the known site or during the survey of PAFB (Table 14, Map 10).

Table 14. All infestations of Dalmatian toadflax at PAFB.

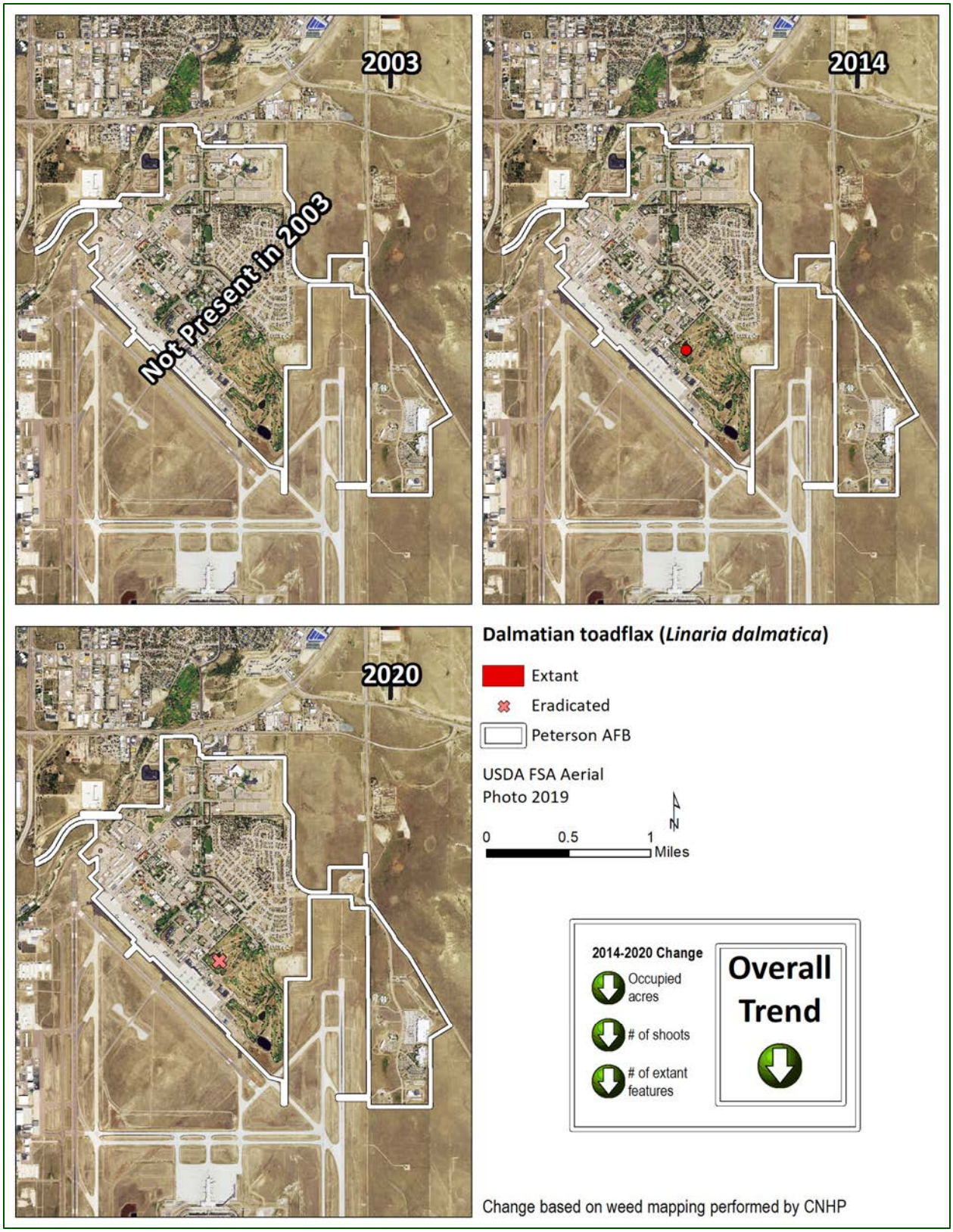
	Occupied Area (Square Meters)	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2003	---	---	---	---
2014	3 m^2	50	1	1
2020	0	0	0	1

Recommendations

Although no plants were observed in 2020, it is important to continue yearly monitoring. Past experience has shown us that this plant can go from no plants at a known location for five or more years and then 50 or even hundreds of individuals can appear all at once, perhaps as a result of a favorable weather conditions. The seed longevity is estimated at 10 years and yearly monitoring at the known sites should continue for at least a few more years at PAFB. Rapid response actions to remove these plants should occur anytime Dalmatian toadflax is observed at PAFB because of how quickly it can get out of control. For the small number of plants hand-pulling and digging are recommended. Remove any flowering or seed heads to a disposal site and monitor annually for at least 10 years.

Monitoring History:

- No plants were mapped at PAFB in 2003.
- In 2014, there was one location with 50 individuals in a three square meter area.
- In 2020, no Dalmatian toadflax was found at the single known site. Yearly monitoring for at least five to 10 years at the known sites is recommended.



Map 10. Distribution of Dalmatian toadflax at PAFB in 2003, 2014, and 2020.

Yellow Toadflax (*Linaria vulgaris*)

Overall Trend: Increasing

Management Goals: Suppression

LIST B

Photos: Yellow toadflax at the Air Force Academy, Colorado Springs. Michelle Washebek 2007 (CNHP).

- Perennial, escaped ornamental.
- Reproduction by seed and creeping roots
- Extensive root system makes successful treatments very difficult
- Flowers June – September
- Hybridizes with Dalmatian toadflax
- Wide genetic variability and hybridization makes it difficult to treat with herbicides (Lajeunesse 1999).
- Biological controls are available for yellow toadflax ().

2020 Results

In 2020, yellow toadflax has continued to increase significantly in cover, number of individuals and number of locations at PAFB since 2003. A total of 14,506 individuals were mapped at six sites at PAFB with a cover 1,312 square meters (Table 15, Map 11).

Table 15. All infestations of yellow toadflax at PAFB.

	Occupied Area (Acres)	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2003	79 m^2	393	1	---
2014	366 m^2	9,139	4	0
2020	1,312 m^2	14,506	6	2

Recommendations

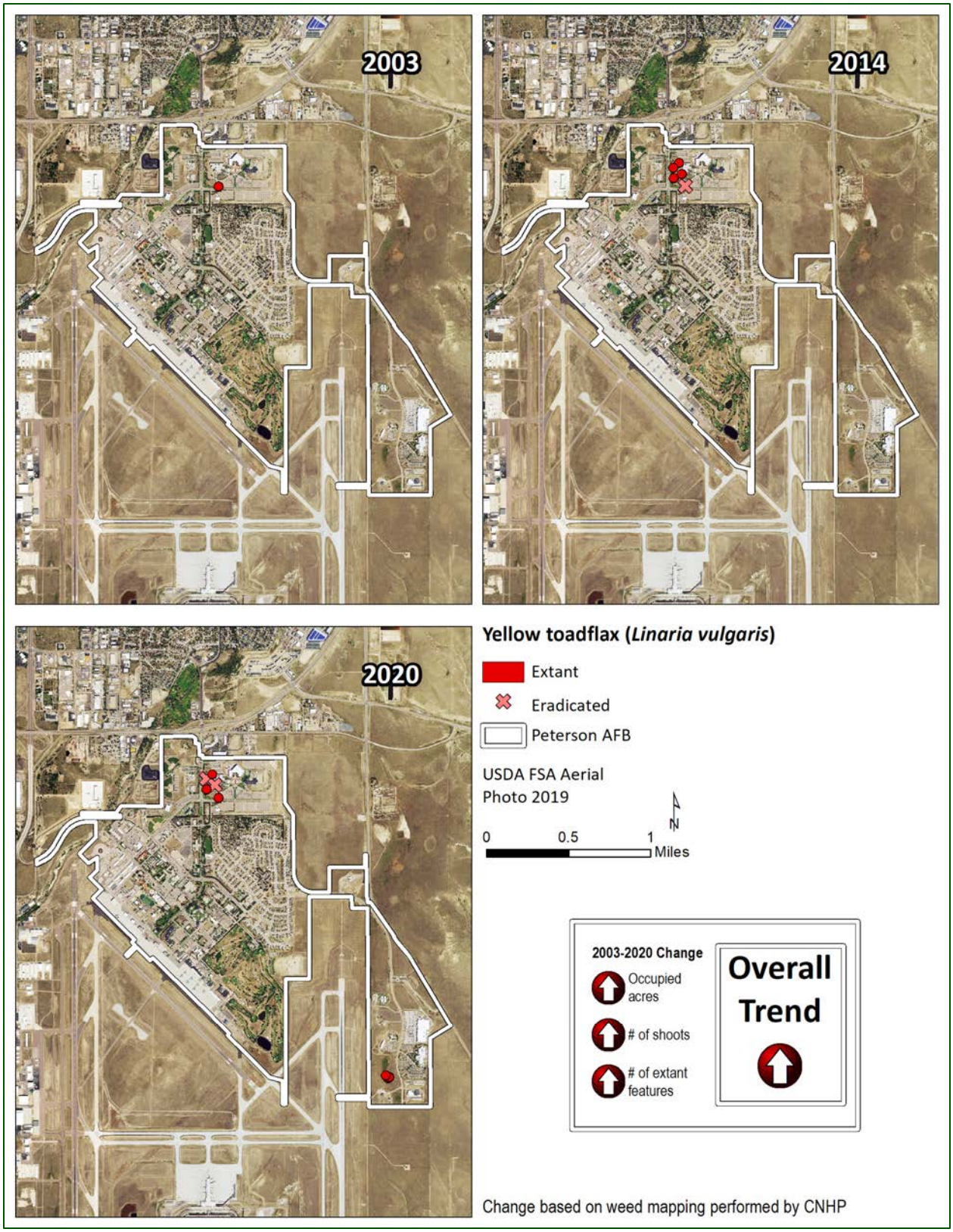
Yellow toadflax is a List C noxious weed that is becoming widespread at PAFB. This species is notoriously hard to treat, even with integration of different methods once it has reached thousands of shoots across a landscape. Therefore, the best treatment is considered to be prevention; keeping yellow toadflax from spreading to other areas by protecting any surrounding intact areas. Pulling around the perimeter of large infestations has been shown to be effective (Carpenter and Murray 1998, Lajeunesse 1999). Pulling toadflax by hand has been shown to be beneficial in smaller infestations by limiting the spread. Early treatment and persistence for multiple years is key for hand-pulling to be effective (Knight 2003, Rice and Randall (2003a, 2003b). Same season repeat treatments contribute to a faster removal and reduction in plants. Replanting some areas can help with preventing toadflax plants from establishing in the manually treated areas.

Biocontrols are available and could be considered. The cover at PAFB needs to be evaluated to see if it is approaching a size that could benefit from biocontrol. Dense areas are recommended for the application of the biocontrol insects, which are currently available from the Colorado Department of Agriculture insectary https://ag.colorado.gov/conservation/biocontrol/yellow-toadflax . These insects will not eradicate an infestation but they will weaken the plants and perhaps slow the spread. Herbicides are not recommended for use with biocontrol organisms.

Chemical control is complicated due to the genetic variability of toadflaxes (Lajeunesse 1999). The recommended herbicides are harmful to surrounding vegetation and often after treatments the result is more noxious weeds occupying the treated areas due to the types of landscapes where yellow toadflax is found. Chemical treatments alone have not been shown to be successful in removing toadflax (Saner et al.1995). Years of follow-up treatments are necessary due to seedbank persistence (Lajeunesse 1999). This is why it is important to evaluate the need for attempting treatment, is it already in a disturbed area where the end result will be more nonnative species moving in to occupy treatment areas.

Monitoring History:

- In 2003, there were 393 yellow toadflax individuals occupying 79 square meters and one location.
- In 2014, there were 9,139 yellow toadflax individuals occupying 366 square meters at four locations close to original infestation from 2003.
- In 2020, yellow toadflax has continued to increase with 14,506 individuals occupying 1,312 square meters mapped at six extant locations at PAFB.



Map 11. Distribution of yellow toadflax at PAFB in 2003, 2014, and 2020.

Purple Loosestrife (*Lythrum salicaria*)

Overall Trend: Eradicated

Management Goals: Monitor for New Occurrences

LIST A

Photos: Purple loosestrife, kingcounty.gov

Showy flowers of purple loosestrife, wikimedia.org

- Long-lived, wetland perennial that can completely dominate a site.
- Tall, showy magenta flower spikes.
- One plant can produce > 2 million seeds the size of ground pepper (King County 2018).
- Seeds viable up to 20 years (CDA 2015).
- Reproduces by rhizomatous roots, seeds and broken stems.
- Simple smooth-edged leaves grow opposite or whorled from stiff, 4-6 sided stems.
- Flowers in spikes at the top of 6-10 feet stems from July to September.

2020 Results

No purple loosestrife plants were observed at PAFB during the 2020 survey. It has been over 17 years since a single plant was observed near a residence in the northeast quarter and it is likely this species has been eradicated at this site (Table 16, Map 12). However, a clear view was obstructed by a residential fence where the plant was originally mapped and there is a chance this plant could still be present.

Table 16. All infestations of purple loosestrife at PAFB.

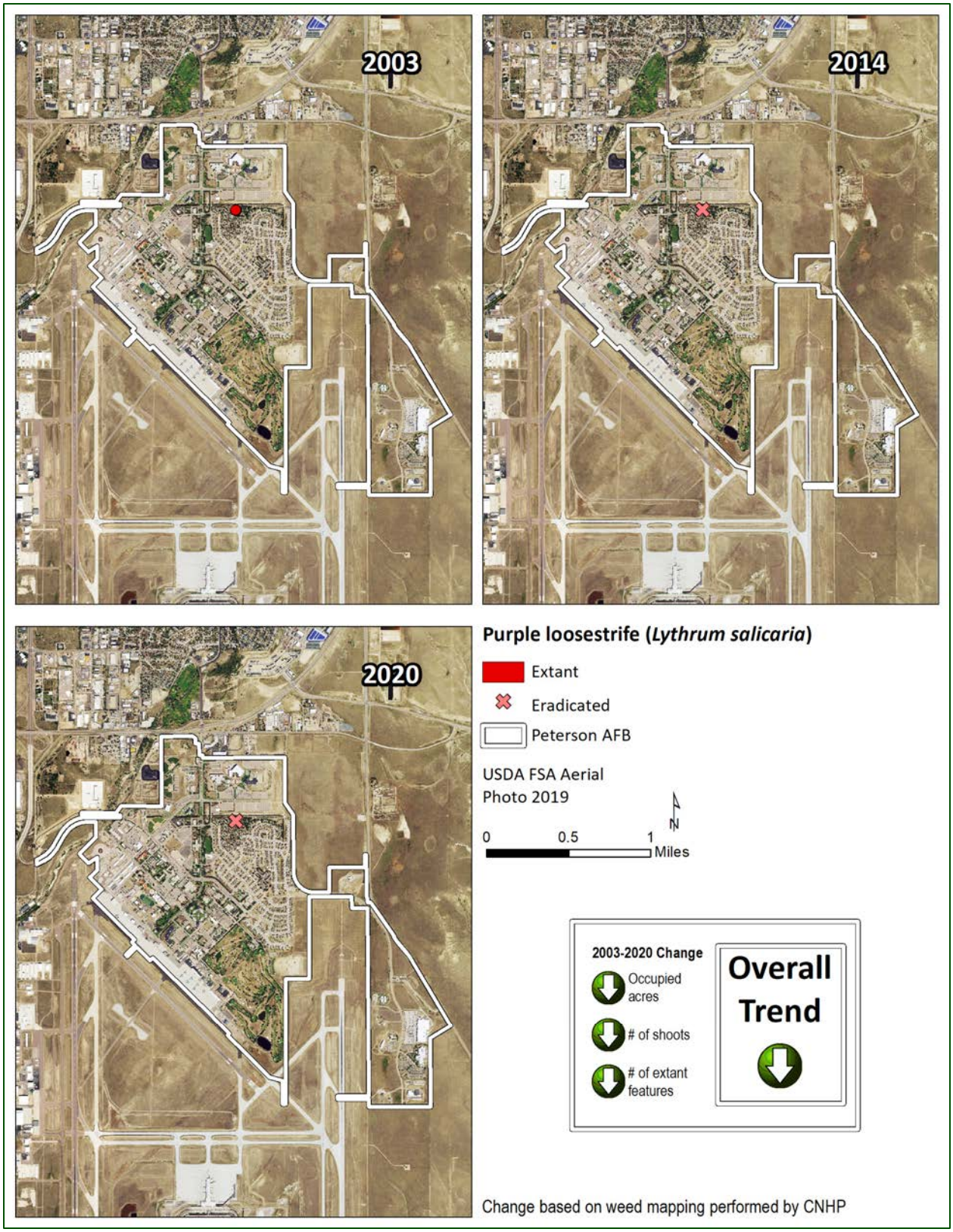
	Occupied Area (Square Meters)	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2003	50 m^2	1	1	0
2014	0	0	0	1
2020	0	0	0	1

Recommendations

Since it has been over 17 years since a single plant was observed at PAFB, purple loosestrife is thought to be eradicated at PAFB. However, the seed longevity is thought to be over 20 years (CDA 2015). In addition, this species is often planted by gardeners even though it is not legal to sell the seeds or plants in Colorado they are available from the internet horticultural trade and are often planted in residential areas where these plant can survive in gardens in drier soils. In addition, the area where the plant was originally mapped did not afford a clear view to be 100% certain there were no plants present. It is prudent to keep watch especially in residential neighborhoods and wetlands at PAFB for this highly invasive ornamental species that escapes readily to wetlands. In some instances, where the seeds have built up in the soil seed bank, large infestations have suddenly appeared. It is difficult to eradicate purple loosestrife once it establishes because it can reproduce by seeds, roots and vegetative growth including stem fragments. All wetlands, ponds, lakes ditches and waterways are potential habitats (King County 2018).

Monitoring History:

- In 2003, a single plant was found in the northeast quarter PAFB.
- In 2014, no plants were found at the known location at PAFB.
- In 2020, no plants were found at the known location and the plant is likely eradicated.



Map 12. Distribution of purple loosestrife at PAFB in 2003, 2014, and 2020.

Bouncingbet (*Saponaria officinalis*)

Overall Trend: Stable

Management Goals: Eradication

LIST B

- Perennial, garden escape
- Self-fertile
- Toxic to humans and wildlife
- Reproduction from seeds and rhizomes
- Colony former
- Blooms summer-fall
- Seed longevity is unknown (CDA-CSU 2019)
- Increases in wetter years

Photo: ct.botanicalsociety.org

Photo: Leaves of mature plant showing three distinctive veins, missouristate.edu

2020 Results

In 2020, bouncingbet is considered to be stable overall; the population having decreased between 2003 and 2014 and then rebounded to the same number of shoots in 2020 as in 2003. There are two extant features in 2020 located on the northwest side of the base (Table 17, Map 13).

Table 17. All infestations of bouncingbet at PAFB.

	Occupied Area (Square Meters)	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2003	50 m^2	201	1	---
2014	31 m^2	10	4	1
2020	41 m^2	200	2	3

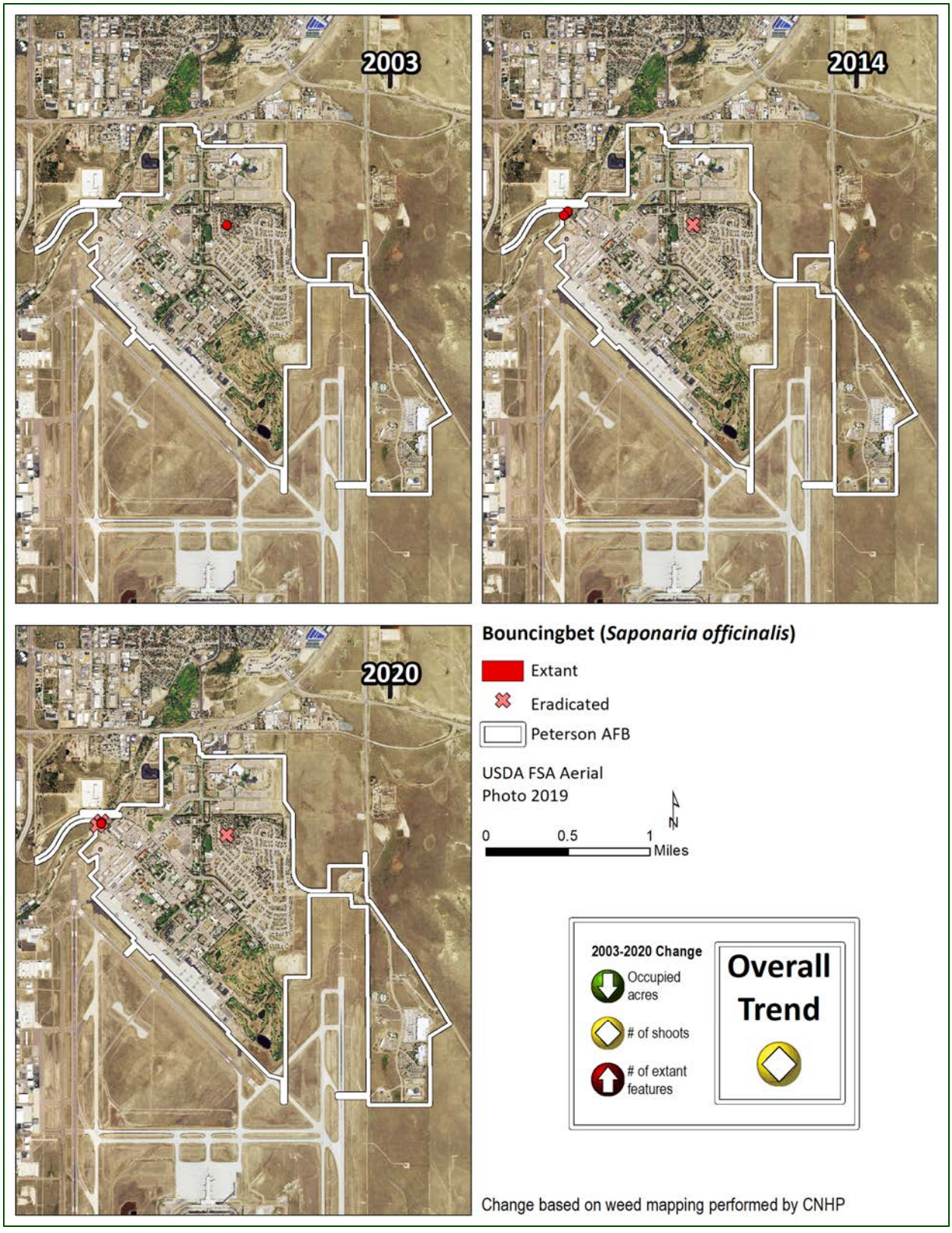
Recommendations

Population swings for this plant appear to be related to spring and summer precipitation with higher rainfall during these months resulting in larger populations of bouncingbet. For PAFB, we would recommend continuous manual removal of the plants with frequent same season visits to remove shoots that will come up. By reducing the above ground parts that can photosynthesize repeatedly over the growing season, you reduce the energy getting to the root system. The small cover and low number of shoots at PAFB make it likely that these two occurrences could be eradicated manually.

Recommendations for bouncingbet treatments often include a combination of IPM with restoration. Most treatments can cause vegetative growth even herbicides. There are no recommendations for herbicide or mechanical treatments alone. In addition, there are no herbicides recommended for treating wildlands**,** only rangelands and pastures (CDA-CSU 2019). The small population at PAFB should be controlled by a few years of persistent continuous removal of the above ground parts.

Monitoring History:

- In 2003, 201 individuals were mapped at a single extant feature at PAFB.
- In 2014, 10 individuals were mapped at four locations. The feature mapped in 2003 did not have any bouncingbet present.
- In 2020, there were 200 shoots mapped at two extant features.



Map 13. Distribution of bouncingbet at PAFB in 2003, 2014, and 2020.

Salt Cedar (*Tamarix ramosissima*)

Overall Trend: Stable

Management Goals: Eradication

LIST B

- Tall shrub or small tree
- Reproduction by roots submerged stems and seeds
- Flowers April-September
- Sprouts if stumps are cut
- Seed longevity is short <1 year
- Provides habitat for nesting birds (USFS FEIS 2016)

Photos: Renee Rondeau (left), Calphotos.berkely.edu (right)

2020 Results

In 2020, no salt cedar was found at the original site mapped in 2003, but the new site observed in 2014, near the northwest boundary at Sand Creek still had a single individual in 2020 (Table 18, Map 14).

Table 18. All infestations of salt cedar at PAFB.

	Occupied Area (Square Meters)	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2003	50 m^2	2	1	---
2014	13 m^2	1	1	1
2020	13 m^2	1	1	1

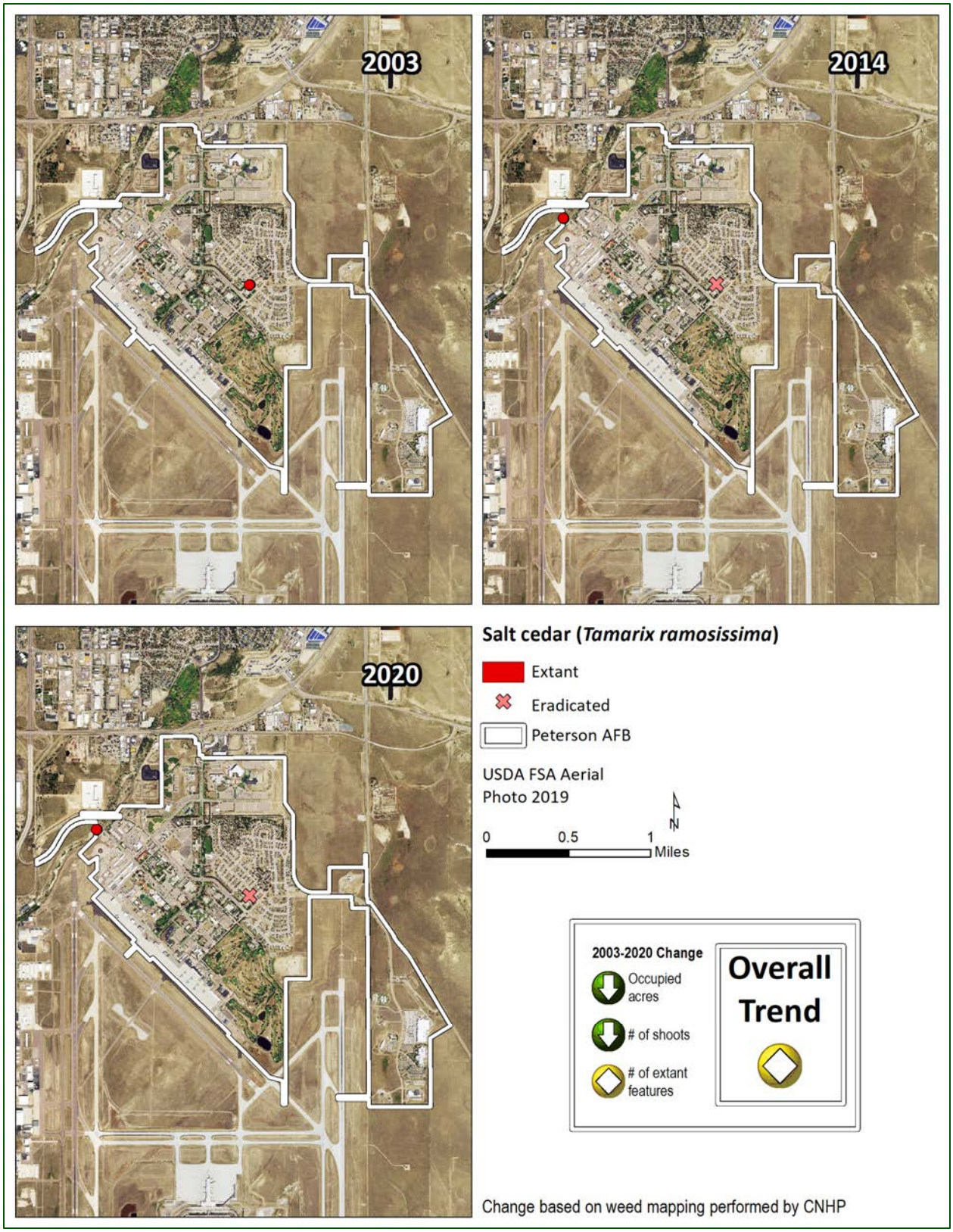
Recommendations

The single plant found at the Sand Creek location in both 2014 and 2020 may be controlled by applying a chemical herbicide to a plant or a cut stump. Constant removal of the upper part of the plant may also be appropriate. The type of treatment should be selected based on the size of the plant and the time of year. Larger plants can be most susceptible to a cut stump method with an herbicide application which needs to be done within a minute of cutting the plant in some cases. The time of year and temperature are important considerations for mechanical and/or herbicide treatments as it will determine if the herbicides will be translocated to the roots to kill the plant.

Because Sand Creek is a source for salt cedar, we recommend continued monitoring especially at areas near Sand Creek and any new occurrences be controlled upon detection. It may be worthwhile to coordinate eradication efforts on Sand Creek with adjacent land managers in order to reduce re-infestation.

Monitoring History:

- In 2003, two salt cedar individuals were mapped at one location on PAFB.
- In 2014, one salt cedar individual was mapped at PAFB at a different location.
- In 2020, one salt cedar individual was mapped at PAFB at the same location as in 2014.



Map 14. Distribution of salt cedar (tamarisk) at PAFB in 2003, 2014, and 2020.

Puncturevine (*Tribulus terrestris*)

Overall Trend: Decreasing

Management Goals: Eradication

LIST C

Photos: Leaves of puncturevine with spiny "goathead" shaped fruits (left and bottom right), fruits and flowers from invasives.org (top center and top right), Pam Smith (CNHP).

- Annual, prostrate herbaceous plant
- Reproduction by seeds
- Flowers June-September (Ackerfield 2015)
- Seed longevity is 4-5 years (CDA-CSU 2009)
- Found roadsides, waste places, old fields
- Relatively easy to eradicate

2020 Results

In 2020, puncturevine is declining with132 individual plants mapped at five locations at PAFB. This represents a significant reduction in shoots compared to 2003 and 2014 (Table 19, Map 15).

Table 19. All infestations of puncturevine at PAFB.

	Occupied Area (Square Meters)	Estimated Number of Shoots	Number of Extant Features	Number of Eradicated Features
2003	968 m^2	2,494	11	---
2014	603 m^2	1,946	8	9
2020	364 m^2	132	5	14

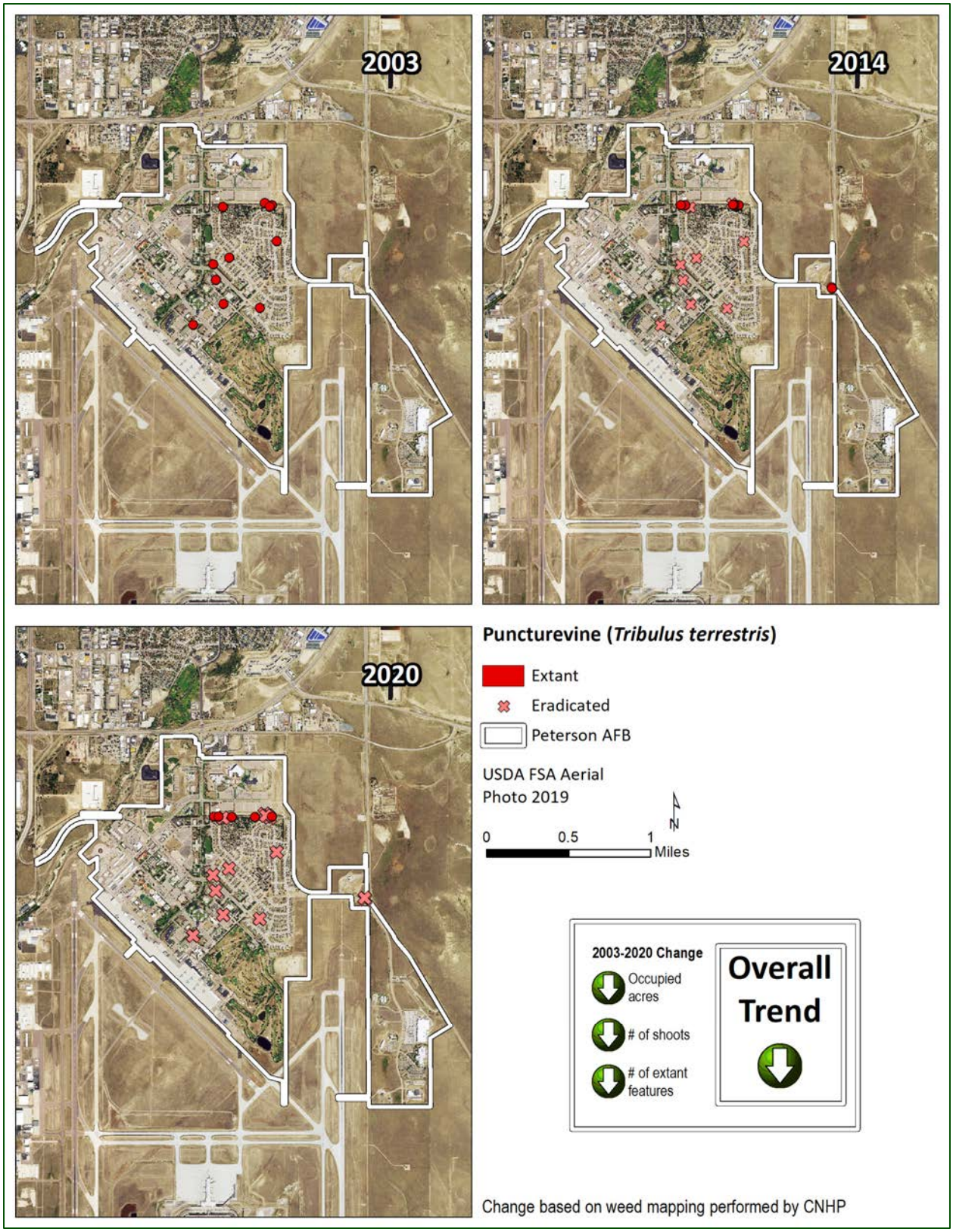
Recommendations

The population has been continuously decreasing since 2003. Puncturevine is an annual species that is comparatively easy to control using manual treatments focusing on seed removal. PAFP is on course to eradicate puncturevine. The stiff spines of puncturevine fruit (burr) promote easy dispersal; therefore, continuous removal is recommended to discourage distribution onto surrounding areas at PAFB. The seed bearing burr is viable for 4 to 5 years (CDA-CSU 2009). We recommend that all previously mapped sites be visited each year for at least five years, as viable seeds are likely to be in the soil bank.

This annual mat-forming species is relatively easy to treat manually because it has a weak root system and it does not matter if you don't get all of the roots. *However, it is extremely important to remove the burrs that contain the seeds,* which can fall off when the plants are being pulled. The burrs can be collected and removed using pieces of carpeting. Since the plant spreads solely by seeds, removal is key to successful eradication efforts. Herbicides may kill the plant *but won't remove the seeds.* It is worth the effort to remove the prickly burrs that fall off of the plants and dispose of them. These efforts will pay off in just a couple of years due to the short seed longevity (CDA-CSU 2009).

Monitoring History:

- In 2003, there were 2,494 shoots at 11 extant features occupying 968 square meters at PAFB.
- In 2014, there were 1,946 shoots at eight extant features occupying 603 square meters. Nine of the 11 features mapped in 2003 were eradicated and there were six new mapped features.
- In 2020, puncturevine is significantly decreasing in the number of extant locations and shoots, with 132 individuals at five extant locations. Eradication is possible.



Map 15. Distribution of puncturevine at PAFB in 2003, 2014, and 2020.

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APPENDIX A. MAPPING PROTOCOL

Noxious weed occurrences were mapped in the field using ArcPad version 10.2 R5 (ESRI 1995-2018), a portable version of GIS software that allows users to efficiently create and attribute spatial data remotely using a tablet computer. ArcPad was installed on a Trimble Yuma rugged tablet with a Windows 7 operating system and a built-in GPS receiver module. The Yuma tablet has improved display capabilities, a rugged exterior to withstand adverse weather conditions, a stable operating system and hard drive, and a large screen to help with navigation and data collection. According to Trimble specifications, the GPS is accurate to within 2-5m using SBAS (Satellite-Based Augmentation System). To ensure data accuracy during the collection process, SBAS was activated and warning systems were enabled in ArcPad to notify the user when the PDOP (Positional Dilution of Precision) exceeded 6. Twenty points were averaged at each location, and 10 vertices were averaged for lines and polygons.

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 30 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 approximately 5 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 keep track of 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 2019 NAIP digital orthophoto quad 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 using the GPS in a specific area (e.g. “on the fly” mapping). 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.

Weed data were stored in an ESRI file geodatabase and the following attributes were captured:

COLLECTDAT – Collection date
PLANSCODE – USDA plants code
SPECIES – Scientific name
COMMONNAME - Common name
NUMINDIV – Number of individuals
DENSITY – Density per square meter
BUFFDIST - Radius for point features; buffer width for line features; not applicable to polygon features

COVERCLASS – 0-1%, Trace; 1-5%, Low; 5-25%, Medium; 25-75%, High; 75-100%, Very High
PATTERN – Continuous or Patchy
COMMENT – Free text field
DATUM – Datum
FEATTYPE – Point, line or polygon
USOWNER – Federal land ownership
LOCALOWNER – Local land ownership
US_STATE – U.S. state
COUNTRY - Country
EXAMINER –Field observer
MAPAGENCY – Mapping agency
STATUS – Extant, Eradicated, Dead Standing, Sprouting, Other

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

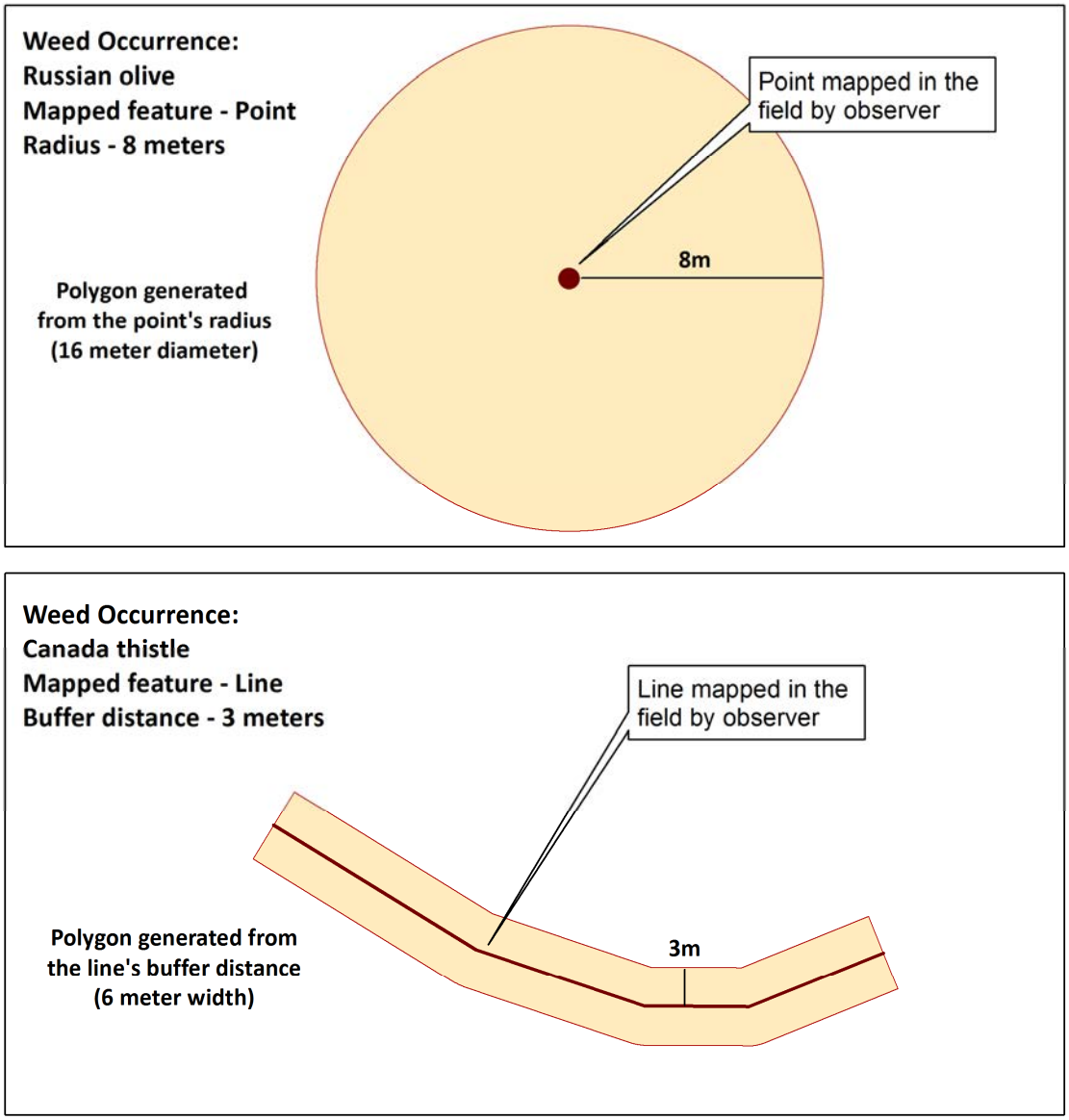

Figure 3. Examples of buffered points and lines.