

Noxious Weed Survey of Peterson Air Force Base



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Knowledge to Go Places

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EXECUTIVE SUMMARY

In the summer of 2003 the Colorado Natural Heritage Program (CNHP) mapped noxious weeds at Peterson Air Force Base (PAFB) east of Colorado Springs, Colorado. The project was undertaken to provide the Peterson Air Force Base 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 Plans, federal and state noxious weed laws, and Executive Order 13112.

Eleven species of weeds were mapped at or near PAFB, three of which are included among the top ten prioritized weed species listed in the Colorado Noxious Weed Act, and all but one of the rest listed on the State Noxious Weed List (Table 1). Mapping was conducted for three weeks between June 23 and July 18, 2003. Arcpad software (ESRI 1987-2003) installed on a handheld mobile device attached to a GPS unit was used to map weed occurrences and record attribute data while traversing PAFB.

While noxious weeds are widespread at PAFB, only three species are found in more than one to a handful of occurrences; furthermore, most occurrences of all species are represented by trace to low cover and/or small numbers of shoots. Russian olive, field bindweed and Canada thistle are the most common noxious weed species at PAFB with high cover and/or dozens of occurrences. Puncturevine, baby's breath, bull thistle and tamarisk each grow at several locations, while yellow toadflax, purple loosestrife and bouncingbet are found at one site each. Serious infestations of four species exist on property belonging to the Colorado Springs Municipal Airport adjacent to PAFB. Swarms of Canada thistle and field bindweed exist along Sand Creek, as well as a significant population of tamarisk. In addition, common St. Johnswort is found within a Municipal Airport retention pond adjacent to the south end of the golf course. Based on their size of infested area, invasiveness, and difficulty of management, species are priority ranked and suggestions made for their management. Management recommendations are also made for particular problem areas of the base. No significant biological resources were found at PAFB during weed mapping.

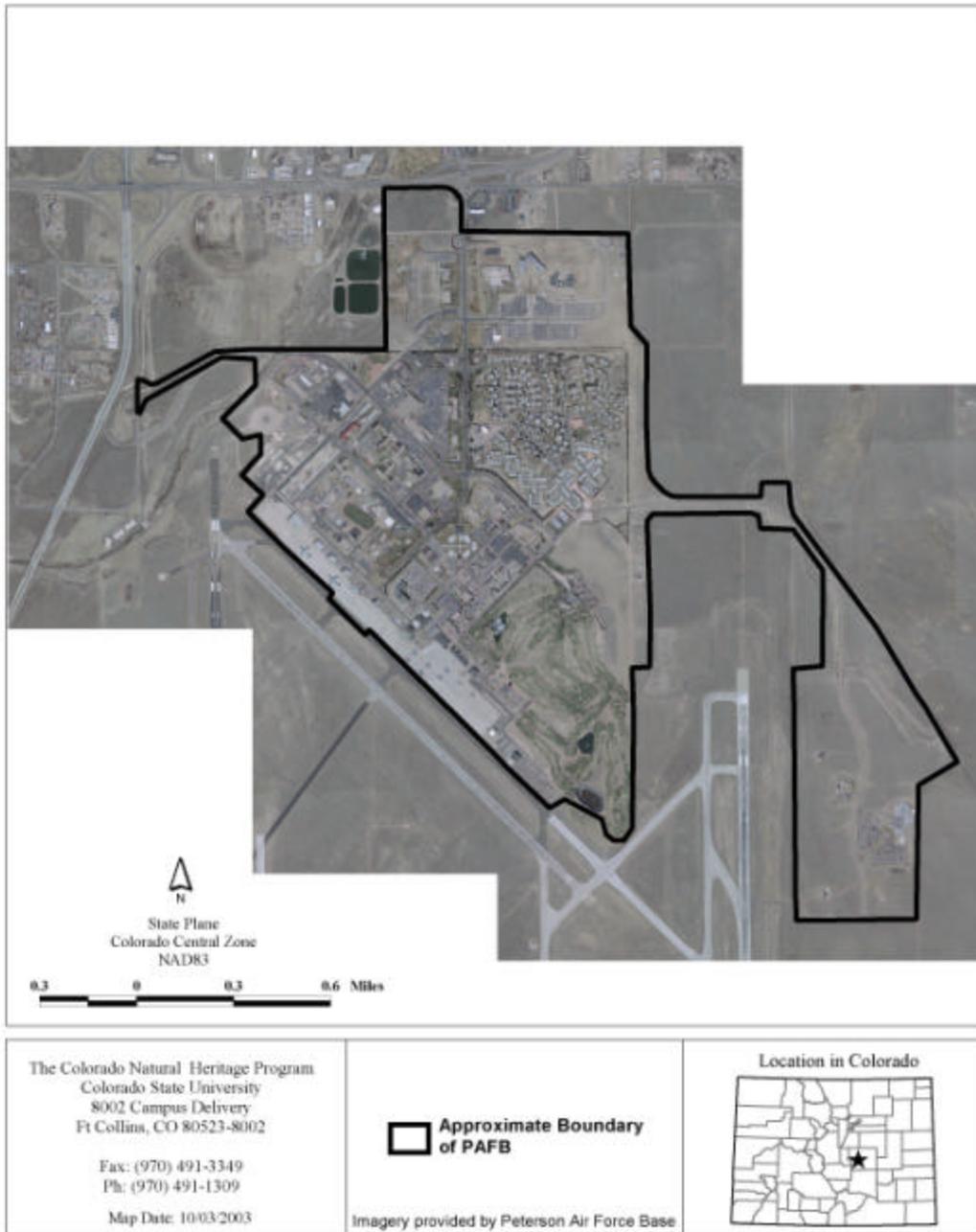
OVERVIEW OF THE STUDY AREA

Much of the following overview is derived from Schuerman *et al.* (1997).

Peterson Air Force Base is located in El Paso County, Colorado seven miles east of downtown Colorado Springs (Figure 1), and lies within the southern Rocky Mountains physiographic region. The main western portion of the base is a highly developed urban area, while Peterson East (PE) is almost entirely open grassland. Elevation ranges from 5,900 to 6,200 feet.

Figure 1. Location of Peterson Air Force Base

Peterson Air Force Base



Climate

The climate of the Colorado Springs vicinity is varied but moderate. The area experiences

typical high plains weather, which can be significantly modified by the mountains located approximately 15 mi to the west. Precipitation averages 16.4 in/yr, a few inches more than the plains to the east but less than the mountains to the west. Sporadic periods of drought can occur in the fall and winter months. Year-round temperatures are moderate, the annual average being 49 degrees Fahrenheit. Average seasonal temperatures range from 35.4 degrees Fahrenheit in winter to 61.6 degrees in summer. Winds in the area of PAFB can be locally intense (Owenby and Ezell 1992).

Geology

The geologic formations of the area are sedimentary and typically Cretaceous (136-65 million yrs BP) and Tertiary (65-3 million yrs BP) in age. Strata underlying PAFB include the Pierre Shale, Fox Hills Sandstone, Laramie Formation and Dawson Arkose. The Dawson Arkose and Laramie Formation primarily contribute the gravelly soils of Peterson East and the moderately sloping land to the south (USDA, SCS 1975; PAFB 1996).

Soils

Two soils are present at Peterson East: Blakeland loamy sand and Blendon sandy loam. These are upland soil types composed of alluvial sand and gravels derived from recently deposited arkosic sandstone. Both soils have low water-retaining capacity and are well suited for deep-rooting grasses such as western wheat grass, side-oats grama and needle-and-thread (USDA, SCS 1975). Sand Creek is dominated by two sandy soils: Ellicott loamy coarse sand and Truckton sandy loam. Except for Sand Creek proper, these soils support either irrigated cultivation or urban development (PAFB 1996).

Fauna

The fauna of PAFB and surrounding area is a mixture typical of both the foothills of the Southern Rocky Mountains and the western edge of the high plains. Pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*) and coyote (*Canis latrans*) can be found nearby, and red fox (*Vulpes vulpes*) actually live on the Silver Spruce Golf Course. Eastern cottontail (*Sylvilagus floridanus*) is present extensively in base housing, while black-tailed prairie dog (*Cynomys ludovicianus*), plains pocket gopher (*Geomys bursarius*), Ord's kangaroo rat (*Dipodomys ordi*), prairie and meadow voles (*Microtus ochrogaster* and *M. pennsylvanicus*, respectively) and deer mice (*Peromyscus spp.*) are present at least in neighboring grassland. Birds common to the plains seen on base include western meadowlark (*Sturnella neglecta*), horned lark (*Eremophila alpestris*), Swainson's hawk (*Buteo swainsoni*) and American kestrel (*Falco sparverius*).

Vegetation and Flora

Plant taxonomic nomenclature for the following description, and throughout this report, is that of Weber and Wittmann (2001).

Most of Peterson Air Force Base consists of a mosaic of highly managed traditional turf, shrub and tree landscaping (upper right photograph), interspersed with lower-maintenance areas featuring swathes of rock mulch (lower right photograph) or xeric grasses and native forbs (lower left photograph). Broad stands of bluegrass lawn are maintained along principal streets and boulevards, and around living quarters. Ponderosa and Austrian pine, green ash, Russian olive, Siberian elm and other common horticultural species and varieties are planted to create a park-like environment; numerous species and varieties of shrubs are utilized for building foundation treatments.



The natural vegetation of PAFB is discernable only at the comparatively undeveloped Peterson East, and comprises mid- to tallgrass prairie within a life zone largely dominated by shortgrass plains. Tallgrass prairie remnants are difficult to distinguish, however, due to the mowing regime (see photograph at right) practiced to one extent or another over the entire base. Needle-and-thread (*Hesperostipa comata*) 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 PE and on the main part of the base, the former especially planted in areas for low maintenance. Six-weeks fescue (*Vulpia octoflora*), Western wheatgrass (*Pascopyrum smithii*) and indian ricegrass (*Achnatherum hymenoides*) can also be found locally. Prickly pear and brittle cacti (*Opuntia polyacantha* and *O. fragilis*, respectively) are common subshrubs at PE and infrequent



elsewhere on base, while suppressed yucca (*Yucca glauca*) and fringed sage (*Artemisia frigida*) can also occasionally be found at PE. A number of forbs are virtually ubiquitous both at Peterson East and at less-intensively managed locations within the developed portion of the base. These include golden aster (*Heterotheca villosa*), sand verbena (*Abronia fragrans*), spiderwort (*Tradescantia occidentalis*), several penstemons (*Penstemon* spp.), the non-weedy native plains and Flodman's thistles (*Cirsium canescens* and *C. flodmanii*, respectively), daisy (*Erigeron* sp.), and cryptantha (*Oreocarya* sp.).

METHODOLOGY

Species of noxious weeds were initially selected for mapping based on these factors: rank on the state noxious weed list (Table 1), known presence of species at U.S. Air Force Academy (Anderson *et al.* 2003), recommendations of natural resources management personnel from Fort Carson (Romero pers. comm. 2003) or CNHP staff, and potential impact on the base environment. Eleven species of weeds were mapped in the study area (Table 2). See Figure 2 for the distribution of noxious weeds.

The data collected in the field conforms to standards established by North American Weed Management Association (NAWMA) (2002). It also meets the needs of the Colorado Department of Agriculture's statewide weed mapping (Colorado Department of Agriculture 2003). All data specified in the Montana Noxious Weed Survey Protocol (Cooksey and Sheley 1998) were gathered for each weed occurrence. The methodology specified in this mapping system was modified to suit the mobile device used to gather data for the project.

All weed occurrences were mapped in the field using ArcPad version 6.0.2 (ESRI 1995-2003), a scaled-down version of ArcView GIS (ESRI 1992-2000) software that allows the user to create and attribute shapefiles using a Portable Digital Assistant (PDA). This software was installed on a 64MB Compaq iPAQ Pocket PC (model H3670) that was equipped with a dual PC card expansion pack. A Teletype GPS unit, which automatically linked to ArcPad and captured coordinate information for weed occurrences, was attached to the iPAQ. Without differential correction, the GPS unit is accurate to within 20 meters, but field trials performed by CNHP found it to be accurate to within 5 meters most of the time, even under heavy tree canopy. The GPS unit is Wide Area Augmentation System (WAAS) capable, and this feature was enabled during the project to enhance data accuracy and integrity. WAAS, a differential correction system developed by the Federal Aviation Administration, produces results of less than 3 meters of error 95% of the time. In order to prevent data loss, all digital files were saved on a PC card and downloaded from the iPAQ to a laptop twice daily, as well as burned onto CDs at the end of each working day.

For details regarding data management procedures used in this project, please see Appendix 2.

Table 1. Colorado Weed Ranks*. The Colorado Noxious Weed Act, Title 35, Article 5.5, C.R.S. (2000) lists species designated as State Noxious Weeds in Colorado. All weeds listed in the act are ranked as follows:

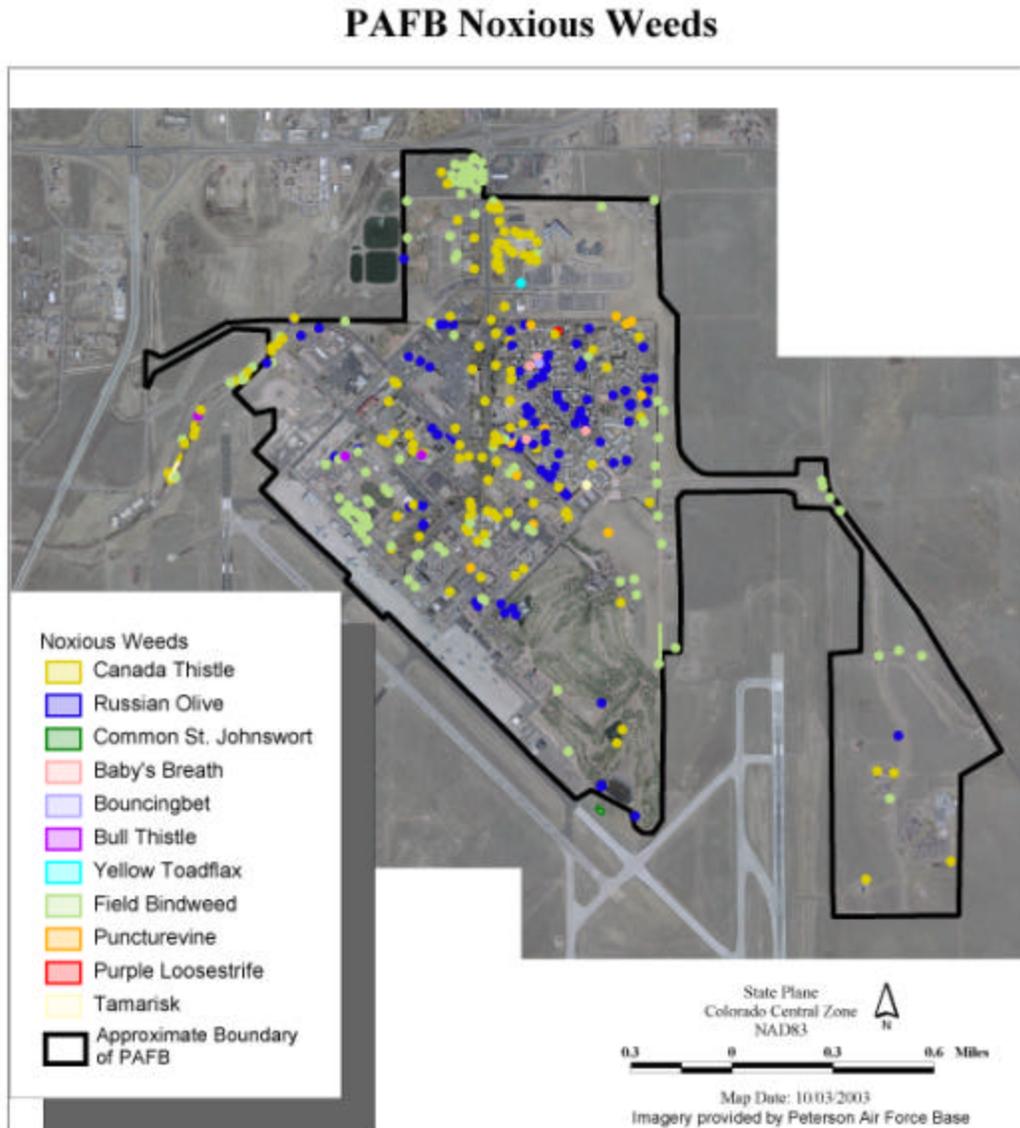
A	State Noxious Weeds. These species have been identified by individual counties as problem weeds in the county's area or have been recommended for management through public testimony.
B	Top Ten Prioritized Weed Species. These weed species are recognized as the top ten prioritized weed species for Colorado. These species are the most widespread and cause the greatest economic impact in Colorado.
C	Not Yet Widespread. These weed species may not yet be present or are not yet widespread or causing great economic impact within Colorado. However, counties and local advisory boards are encouraged to contain and eradicate these species before they proliferate and significantly impact the economic and environmental values of the lands of the state.

*Effective August 6, 2003, the Colorado Noxious Weed Act was amended, basing the ranking of state noxious weeds upon concepts of priority different from those above; because fieldwork for this project was completed before the change, and the new ranking system is likely yet to have been applied by the local weed board for El Paso County, the above ranking system is retained in this report.

Table 2. Weed species mapped at Peterson Air Force Base. See Table 1 for an explanation of weed ranks under the State Noxious Weed Act.

USDA CODE	SCIENTIFIC NAME	COMMON NAME	RANK
CIAR4	<i>Breca arvensis</i> (= <i>Cirsium arvense</i>)	Canada Thistle	B
CIVU	<i>Cirsium vulgare</i>	Bull Thistle	A
COAR4	<i>Convolvulus arvensis</i>	Field Bindweed	B
ELAN	<i>Eleagnus angustifolia</i>	Russian Olive	A
GYPA	<i>Gypsophila paniculata</i>	Baby's Breath	NA
HYPE	<i>Hypericum perforatum</i>	Common St. Johnswort	C
LIVU2	<i>Linaria vulgaris</i>	Yellow Toadflax	B
LYSA2	<i>Lythrum salicaria</i>	Purple Loosestrife	A
SAOF4	<i>Saponaria officinalis</i>	Bouncingbet	A
TARA	<i>Tamarix ramosissima</i>	Tamarisk	A
TRTE	<i>Tribulus terrestris</i>	Puncturevine	A

Figure 2. Noxious weed occurrences at PAFB



Weed infestations were mapped using tolerances recommended by Cooksey and Sheley (1998). Large infestations were mapped as polygons. Linear infestations, such as those following roads, were mapped as lines. All other infestations, which make up the majority of the infestations encountered in the study area, were mapped as points. Please see Appendix 3 for figures illustrating the different feature types.

Attributes were ascribed to all features mapped in the field. These include weed species, date, area of infestation, and density. Area was determined by documenting the radius of point occurrences and the buffer distance of line occurrences. All radii and buffers were determined in the field. Density is determined either as the number of shoots counted (for small populations) or as number of shoots per square meter (for large populations).

Notes were taken about an infestation where unusual or noteworthy observations were made. All of these attributes are included in the attribute tables of the GIS files accompanying this report and are summarized in Table 3.

Data were collected entirely by one person covering 1,200 acres over three weeks between June 23 and July 18, 2003. On a daily basis, a ca 90-acre area bounded by identifiable man-made features such as buildings, roads, and streets, was arbitrarily defined. The defined area was then surveyed by intensive search, or by grid transects with overlapping lines-of-sight.

A few small areas could not be surveyed directly due to difficulty or impossibility of access. The munitions storage yard near Mitchell Avenue and the playgrounds of childcare facilities, for example, were thoroughly inspected for presence of noxious weeds from outside boundary fences by means of binoculars only.

Deliverables on compact disk include 1) photographs of representative infestations of noxious weeds, 2) a digital version of this report, and 3) GIS files and federally compliant metadata.

RESULTS AND DISCUSSION

Table 3. Area Occupied by Weeds Sampled, Estimated Number of Shoots in Sampled Area, Invasiveness, and Suggested Priority for Management of weed species mapped at Peterson Air Force Base. Due to overlap in the presence of the selected weed species, the total occupied area is less than the sum of the occupied area of the individual weed species.

Common Name	Scientific Name	Area Occupied (acres)	Estimated Number of Shoots in Sampled Area	Number of mapped features	Invasiveness at PAFB	Suggested Priority for Management
Russian Olive	<i>Eleagnus angustifolia</i>	5.62	120	89	low	high
Field Bindweed	<i>Convolvulus arvensis</i>	2.93	20,457	115	high	moderate
Canada Thistle	<i>Breca arvensis</i> (= <i>Cirsium arvense</i>)	1.9	12,846	123	high	moderate
Tamarisk	<i>Tamarix ramosissima</i>	.57	46	3	low	high
Puncturevine	<i>Tribulus terrestris</i>	.23	2,487	11	moderate	moderate
Common St. Johnswort	<i>Hypericum perforatum</i>	.15	7,313	2	low	high
Baby's Breath	<i>Gypsophila paniculata</i>	.05	6	4	moderate	moderate
Bull Thistle	<i>Cirsium vulgare</i>	.04	144	3	moderate	moderate
Yellow Toadflax	<i>Linaria vulgaris</i>	.02	390	1	high	high
Purple Loosestrife	<i>Lythrum salicaria</i>	.01	1	1	low	high
Bouncingbet	<i>Saponaria officinalis</i>	.01	200	1	low	low
TOTAL:		11.5		353		

Rationale for Suggested Management Priorities in Table 3

The management priorities developed for the noxious weed species found at PAFB are derived from occurrence and cover information from the 2003 survey, from understanding of the biotic potential of each species, and from the level of control judged to be reasonably attainable on base.

For example, field bindweed and Canada thistle are among the three weeds at PAFB with the highest cover, and are among the top ten prioritized weeds in Colorado. They reproduce vigorously both from seed and by vegetative means, are fast growing, and highly invasive, making them serious potential threats. However, complete eradication of these two weeds from base is an unrealistic goal, and the current management regime is maintaining an excellent level of control. Russian olive possesses the greatest cover of all noxious weeds on base, and poses a serious threat to more-natural wetland systems in the surrounding community. Russian olive is slow growing and could be completely, and permanently eliminated from base. Therefore, Russian olive has been assigned a high priority for management, while field bindweed and Canada thistle are given a moderate management priority.

Other weed species are such serious threats to PAFB and/or the natural systems of the surrounding community that they have been assigned high priority despite very low cover and number of occurrences on base. Yellow toadflax, tamarisk and purple loosestrife all reproduce vigorously both from seed and by vegetative means and are fast growing and highly invasive. However quick, decisive action could completely eliminate them from PAFB because their number of occurrences is so low. Therefore, these species are assigned high management priority to mitigate future weed management burdens on PAFB and the surrounding community.

Noxious Weed Status by Species

Most of the information on growth characteristics, control, and economic, ecological and other deleterious effects of noxious weeds within the following status descriptions is found in *Creating an Integrated Weed Management Plan* (Colorado Department of Agriculture and Colorado Natural Areas Program (CDA/CNAP) 2000).

With the exception of a few trouble spots, noxious weeds at PAFB seem well controlled by the management regime currently being practiced on base. Unless a particular management strategy is stated, it should be assumed that the recommendation by CNHP for noxious weed control should be the continuation of current management practice.

Maps illustrating distribution of noxious weed species found during this project follow in Appendix 1.

Russian Olive (*Eleagnus angustifolia*)

Although relatively few individuals were mapped, this species occupies the largest area at PAFB because of the large size of those individuals. Russian olive is a common landscaping element on the base, especially within base housing. This weedy tree is becoming a serious problem along the Front Range and elsewhere in Colorado, invading wetlands and out-competing native species. The comparatively slow growth rate and small number of trees make complete elimination from the base an attainable goal. Russian olive currently poses a threat at PAFB only within the Sand Creek drainage; still, trees remaining on base would continue serving as a source of seed and pollen which would contribute to persistence and spread of Russian olive within more-natural wetland systems nearby. See Figure 3 for the distribution of Russian olive at PAFB.



Field Bindweed (*Convolvulus arvensis*)

Field bindweed occupies the second-largest area of all noxious weed species at PAFB. This species and Canada thistle are widely present and currently under exceptionally good control on base, but grow freely in significant swarms within the portion of Sand Creek managed by Colorado Springs Municipal Airport. Both species reproduce with extreme vigor both from seed and by vegetative means, and are highly persistent. See Figure 4 for the distribution of field bindweed at PAFB.



Canada Thistle (*Breea arvensis*)

Canada thistle occupies the third-largest area of all noxious weed species at PAFB. Many plants grow in refugia, that is, locations where the plants are unobtrusive or difficult to impossible to remove without destroying desirable plants. Many occurrences of both field bindweed and Canada thistle have been kept suppressed, but cannot be entirely eliminated by the rigorous management regime currently practiced. A reduction of management pressure could allow either



species to become a much greater problem at PAFB. See Figure 5 for the distribution of Canada thistle at PAFB.

Tamarisk (*Tamarix ramosissima*)

Three occurrences of tamarisk were discovered during this survey, one in base housing, and two serious infestations along Sand Creek. As with Russian olive, tamarisk is a threat to PAFB only within the Sand Creek drainage. On a statewide basis, however, tamarisk has proven to be an enormous threat to wetland systems, and is a growing problem within more-natural wetlands of the southern portion of the Front Range in Colorado. For the same reason presented in connection with Russian olive, tamarisk should be eradicated from PAFB, and Colorado Springs Municipal Airport should be encouraged to do all it can to eliminate the plant from the portion of Sand Creek that it maintains. See Figure 6 for the distribution of tamarisk at PAFB.



Puncturevine (*Tribulus terrestris*)

Puncturevine is mapped in several locations at PAFB but, judging from the daily presence of the spiny fruit upon the soles of footwear of the field technician, is probably more widespread than this survey reflects. As with field bindweed and Canada thistle, puncturevine is actively managed by base grounds maintenance personnel. Puncturevine is principally an irritating source of flat bike tires in urban areas such as PAFB, but in agricultural settings the spiny fruit of this noxious weed present an economic threat, damaging wool production and physically harming animals. The stiff spines of puncturevine fruit promote easy dispersal; therefore, the weed should continue to be rigorously suppressed at PAFB so as not to serve as a source of contagion for surrounding areas. See Figure 7 for the distribution of puncturevine at PAFB.

Common St. Johnswort (*Hypericum perforatum*)

Two significant occurrences of common St. Johnswort were discovered within the Colorado Springs Municipal Airport retention basin into which detention pond #2 of the Silver Spruce Golf Course overflows. In an agricultural setting, common St. Johnswort is poisonous to livestock, causing a condition known as the “blind staggers.” While this species was not found along the portion of Sand Creek mapped in 2003, it easily could spread to that drainage



and thus poses a threat to PAFB and the surrounding community. Control of this noxious weed species, as well as field bindweed and Canada thistle along Sand Creek, poses a challenge to managing agencies because they grow within active water drainage systems. However, common St. Johnswort is one of the most successfully managed noxious weeds by means of biological control. Biological controls exist, too, for both field bindweed and Canada thistle, and active biocontrol programs are currently being developed for all three species at nearby Fort Carson and/or U.S. Air Force Academy (Michels *et al.* 1997, Michels *et al.* 1998, Michels *et al.* 2000, Michels *et al.* 2001). Common St. Johnswort, as well as field bindweed and Canada thistle swarms along Sand Creek, may therefore be excellent candidates for biocontrol management. See Figure 8 for the distribution of common St. Johnswort at PAFB.

Baby's Breath (*Gypsophila paniculata*)

This plant is found at PAFB in a few locations within base housing. Although not yet considered a threat within Colorado at large, this plant has been observed at nearby Peyton, Colorado to aggressively naturalize upon soil types similar to those at PAFB. Baby's breath may warrant future consideration for inclusion on the Colorado State Noxious Weed List. Complete removal of the plant now from PAFB is advisable to avoid imminent difficulties, and is possible because there are but few occurrences. See Figure 9 for the distribution of baby's breath at PAFB.

Bull Thistle (*Cirsium vulgare*)

Three small populations of bull thistle were found in various locations at PAFB and Sand Creek. While bull thistle is a serious problem in some places in Colorado, it is unlikely to pose a threat at PAFB, since the non-perennial growth habit of this weed makes it easy to control by mowing under the current management regime. See Figure 6 for the distribution of bull thistle at PAFB.

Yellow Toadflax (*Linaria vulgaris*)

Although found for the first time at only a single location on base, yellow toadflax poses a serious threat to PAFB and areas nearby. Yellow toadflax has proven to be a highly aggressive noxious weed at U.S. Air Force Academy, particularly within shrub communities (Anderson *et al.* 2003). Yellow toadflax reproduces vigorously both from seed and by vegetative means, and were it to become established within the many shrub beds at PAFB, it could never be selectively extricated.



While the yellow toadflax occurrence has already been treated with herbicide, the location should continue to be monitored for a few years to detect any recruitment from

seed, and any plants found immediately destroyed. See Figure 9 for the distribution of yellow toadflax at PAFB.

Purple Loosestrife (*Lythrum salicaria*)

Purple loosestrife is found at PAFB in only one location within base housing. Purple loosestrife is a highly aggressive noxious weed in wetlands of the eastern United States, and is an incipient threat to riparian and other wetland systems in eastern Colorado. The horticultural variety of purple loosestrife present in base housing is probably seed-sterile, but still capable of producing pollen, and thus is unlikely to pose a threat to PAFB, even along Sand Creek. Still, as with Russian olive, plants remaining on base would continue serving as a source of pollen which would contribute to persistence and spread of any fully fertile purple loosestrife plants within more-natural wetland systems nearby. Landscape installation of purple loosestrife should be disallowed in the future to remain compliant with Colorado state law. See Figure 9 for the distribution of purple loosestrife at PAFB.



Bouncingbet (*Saponaria officinalis*)

Bouncingbet is found at PAFB in one location within base housing. Bouncingbet is locally problematic in Colorado, lining miles of roadside in certain portions of Boulder County, for instance. While not as inherently serious a noxious weed as purple loosestrife, bouncingbet could spread to Sand Creek and thus poses a threat to PAFB and the surrounding community. As with baby's breath and purple loosestrife, complete removal from the base is possible since there is only one occurrence. Landscape installation of bouncingbet should be disallowed in the future to remain compliant with Colorado state law. See Figure 9 for the distribution of bouncingbet at PAFB.



Management Recommendations for Particular Trouble Spots

Excellent information on specific materials and strategies for control of noxious weeds at the following trouble spots is found in Creating an Integrated Weed Management Plan (CDA/CNAP 2000).

Headquarters, Air Force Space Command (Hartinger Building)

The landscape surrounding Headquarters, Air Force Space Command represents the greatest combination of cover and occurrence at PAFB for Canada thistle. A number of weed occurrences are found in mulched beds surrounding the building and at least partially separated from desirable landscape plants. This would allow the application of more powerful herbicides in a campaign to eliminate these occurrences altogether.

It is possible that these weeds originated as contaminants in landscaping materials installed by the original landscape contractors. A more rigorous program of inspection of landscaping materials before installation might help eliminate such a source of weed infestation in the future (Mann pers. comm. 2003a). See Figure 10 for the distribution of noxious weeds near the Hartinger Building.

Future Recreation Center Site, West of North Entrance

The east half of this site, along with the ground surrounding trees on the west side of Peterson Boulevard leading to the North Entrance, represents the greatest combination of cover and occurrence at PAFB for field bindweed. While the site is slated for construction, building is not scheduled to begin for some time. Because field bindweed spreads so vigorously by vegetative means, it not only will likely persist on-site after the recreation center is finished, but may also serve as a source of contamination for the rest of the base as soil is moved about during construction.

Because no desirable landscape plantings are on-site, broad-scale treatment using powerful herbicides might achieve a high level of control, or even elimination of the weed from the site. Careful application would have to be made, and a non-root-absorbed herbicide used around trees along Peterson Boulevard to avoid damaging them. Autumn application of herbicide might enhance the treatment effect at a time of year when field bindweed more actively translocates material from leaves to roots and rhizomes for storage. See Figure 11 for the distribution of noxious weeds near the future recreation center site.

Hamilton Avenue, and Skeet & Trap Range

The less-intensively managed land adjacent to Hamilton Avenue, and that comprising the skeet & trap range represent another high combination of cover and occurrence of field bindweed. Again, desirable landscape plantings are not present on-site to preclude the use of more powerful herbicides. All of the preceding particular trouble spots will require careful monitoring for some years to control weed recruitment from the extensive seed bank which no doubt has developed at each location. See figures 12 and 13 for the distribution of noxious weeds near Hamilton Avenue and the skeet and trap range.

General Management Recommendations

Especially in comparison to other facilities such as U.S. Air Force Academy, Peterson Air Force Base is in exceptionally good condition with regard to noxious weeds. 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 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 general recommendations are made:

- Maintain vigilance toward the presence of small pioneer populations of noxious weed species not previously found at PAFB, and rapidly eradicate those populations when discovered.

The best strategy toward noxious weeds is always to prevent their establishment in the first place, and PAFB finds itself in a position of luxury of being able to entirely avoid certain noxious weeds ever becoming the serious problem they are elsewhere (The recent discovery of the single occurrence of yellow toadflax at Peterson Air Force Base is a case in point). A stipulation might be included now and in the future in the contract of the landscape maintenance company that at least one staff person be retained who is knowledgeable in recognition of noxious weeds to provide early warning of future problems (Mann pers. comm. 2003b).

- Be aware of plantings around base housing, and develop a policy for removal of noxious weed species inadvertently planted by base personnel.

Again, the presence on base of a knowledgeable contract worker capable of identifying noxious weeds in the landscape would be helpful. Base housing areas should be inspected at least once a year. If problem plantings cannot be eliminated immediately, removal can be accomplished when base personnel are transferred.

- Continue the rigorous management of noxious weeds currently practiced at PAFB.

Overall, the current management of noxious weeds at PAFB by grounds maintenance personnel is outstanding. Timely mowing, spraying and pulling by hand has been highly successful and largely responsible for the low cover and/or small numbers of shoots found in most weed occurrences on base. It must be understood, however, that while such practices do eliminate many individual weeds, others simply continue indefinitely in a suppressed condition. In addition, some weeds invariably grow in overlooked or hard-

to-get-to locations, such as within shrub beds or beneath trees. At a certain point after establishment, total eradication of a noxious weed species becomes impossible, and the realistic goal then must shift to managing that weed at some acceptably low level. Two of the most common noxious weed species at PAFB, field bindweed and Canada thistle, are now in this category. The potential always exists, however, for suppressed weeds to rebound and become a serious problem in the future if diligence is not kept.

- Make elimination of Russian olive from base a management goal.

In conjunction with the preceding suggested approach toward Canada thistle and field bindweed, total removal of Russian olive would bring the three most serious noxious weeds at PAFB to an excellent level of control. While Russian olive might not hold the potential for becoming the problem at PAFB that it is in other parts of Colorado, PAFB would be setting a good example by undertaking total removal, and would be making a positive contribution to conservation of the natural environment of the broader Colorado Springs community. Given the maturity of base landscaping, total removal would be comparatively painless. Russian olive comprises only a small percentage of the trees at PAFB. Removal could be accomplished in stages and the lost trees gradually replaced (Mann pers. comm. 2003c) by any number of beautiful, and more appropriate species. Lastly, once completed, removal would essentially be permanent.

- Encourage better management of noxious weeds at Colorado Springs Municipal Airport, and coordinate PAFB noxious weed management with those efforts.

PAFB has a vested interest in the management of noxious weeds along portions of Sand Creek, and other areas nearby, which are currently the responsibility of the Colorado Springs Municipal Airport. PAFB may one day assume a greater management role (through purchase or otherwise) over more of Sand Creek, or elsewhere close by; inheriting the weed problems that exist in these areas now will complicate future management. Even if such expansion does not occur, 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.

- Repeat the mapping of noxious weeds at PAFB in five years.

Regardless of the management options selected by natural resources management and grounds maintenance personnel, periodically re-mapping the weeds on base is important for evaluating the effectiveness of management choices (Mann pers. comm. 2003d).

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APPENDIX 1: NOXIOUS WEED MAPS

Figure 3. Russian olive occurrences at PAFB

Russian Olive (*Eleagnus angustifolia*)

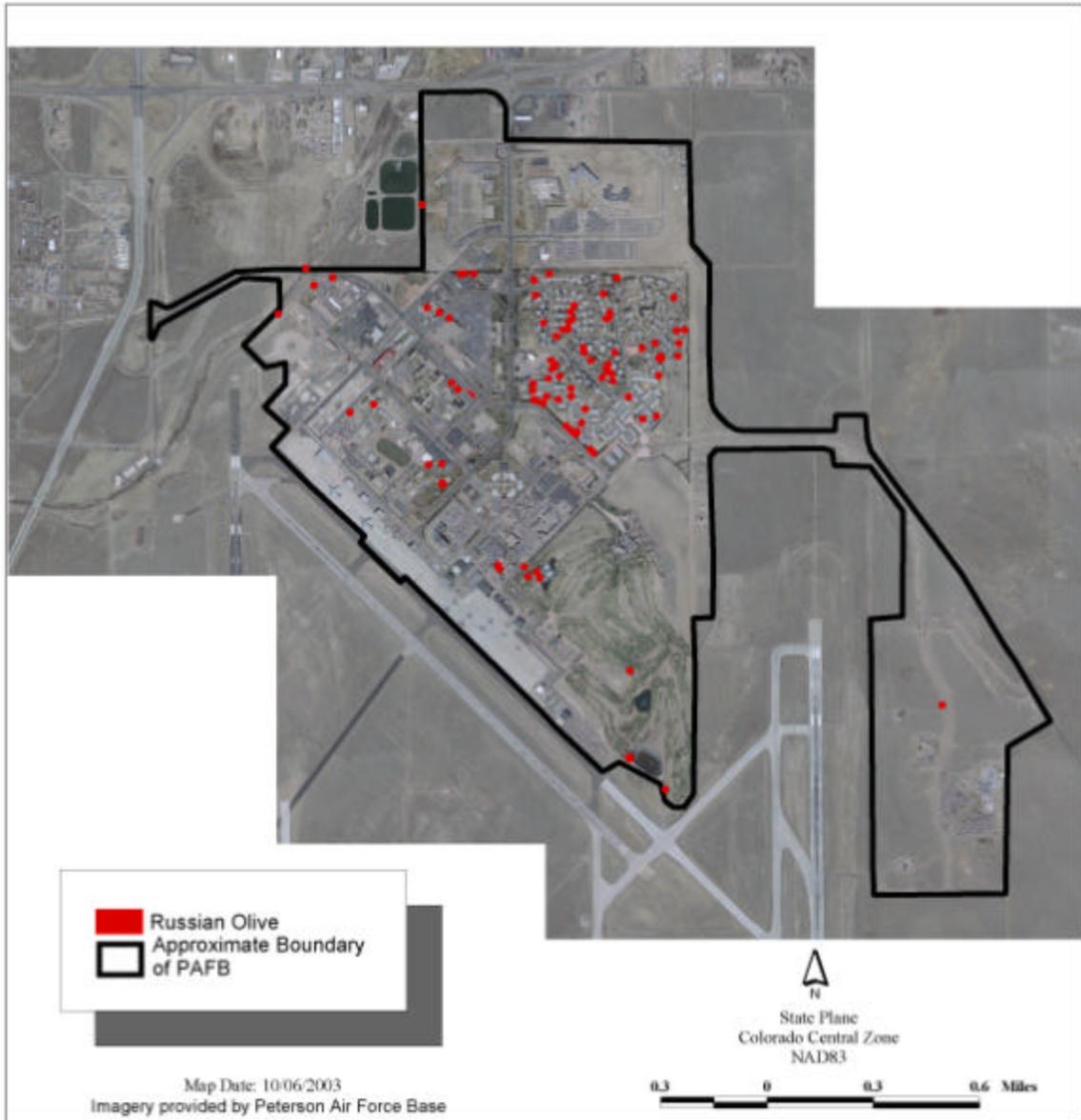


Figure 4. Field bindweed occurrences at PAFB

Field Bindweed (*Convolvulus arvensis*)

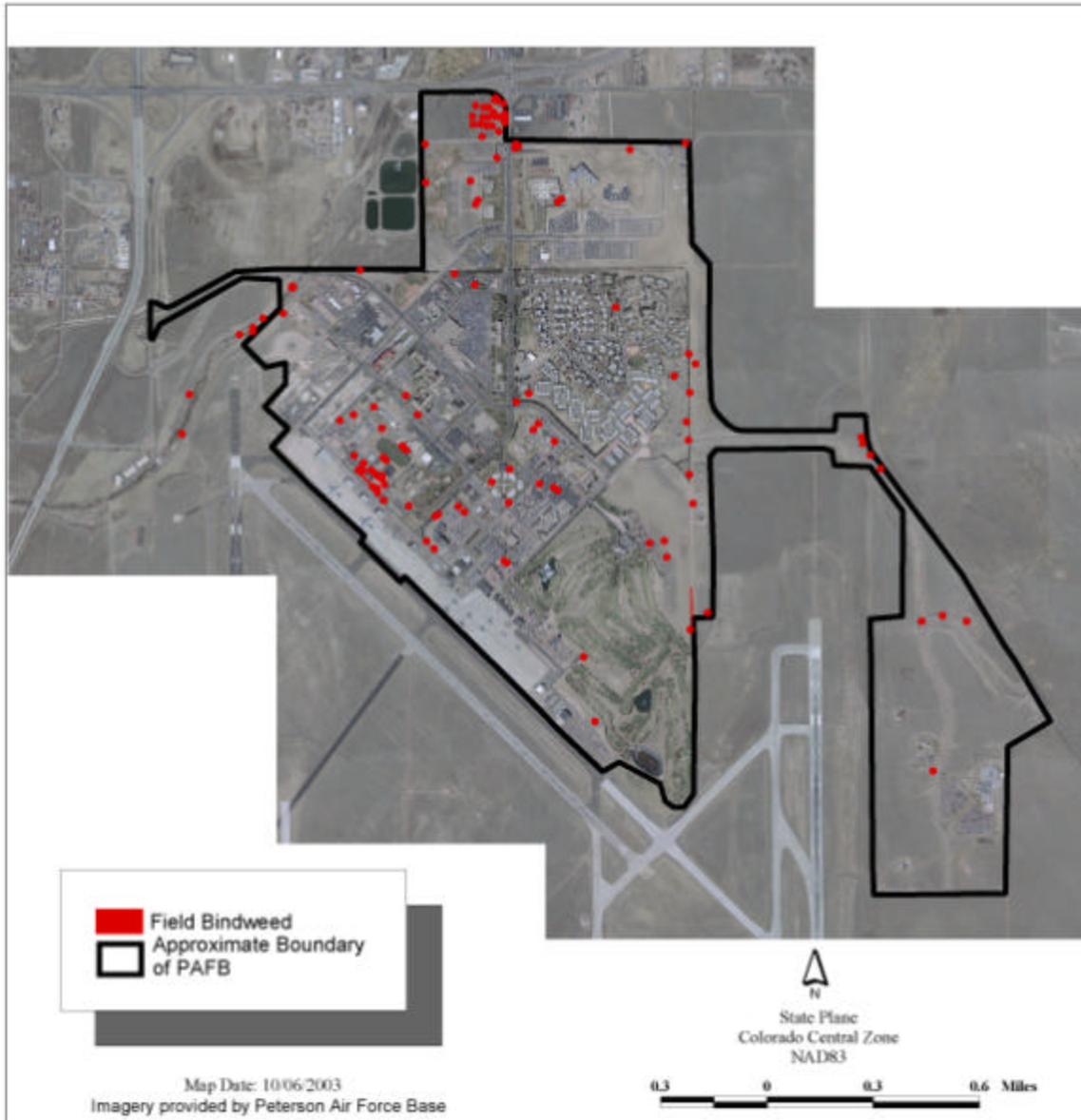


Figure 5. Canada thistle occurrences at PAFB

Canada Thistle (*Cirsium arvense*)

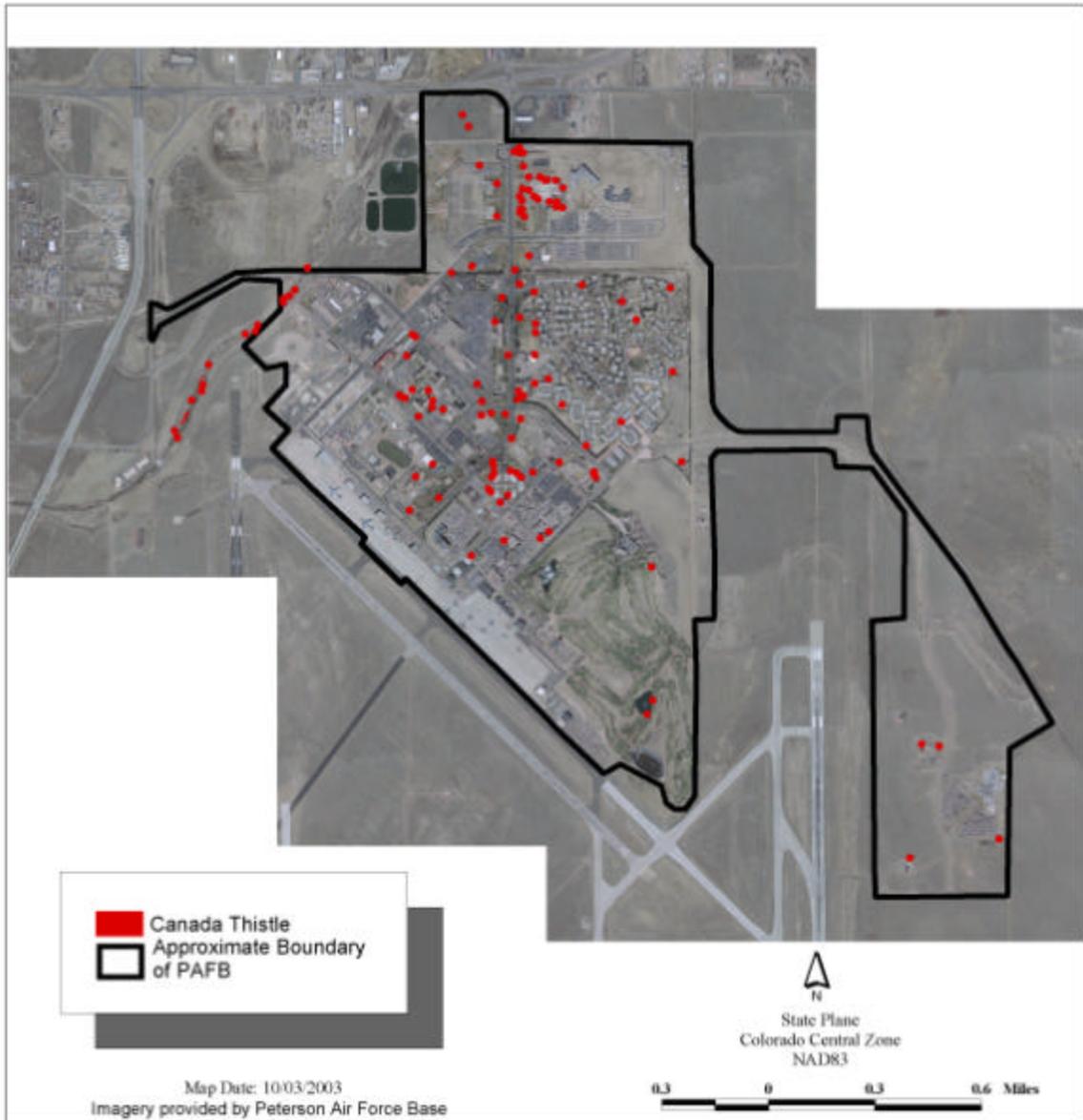


Figure 6. Tamarisk and bull thistle occurrences at PAFB

Tamarisk (*Tamarix ramosissima*) and Bull Thistle (*Cirsium arvense*)

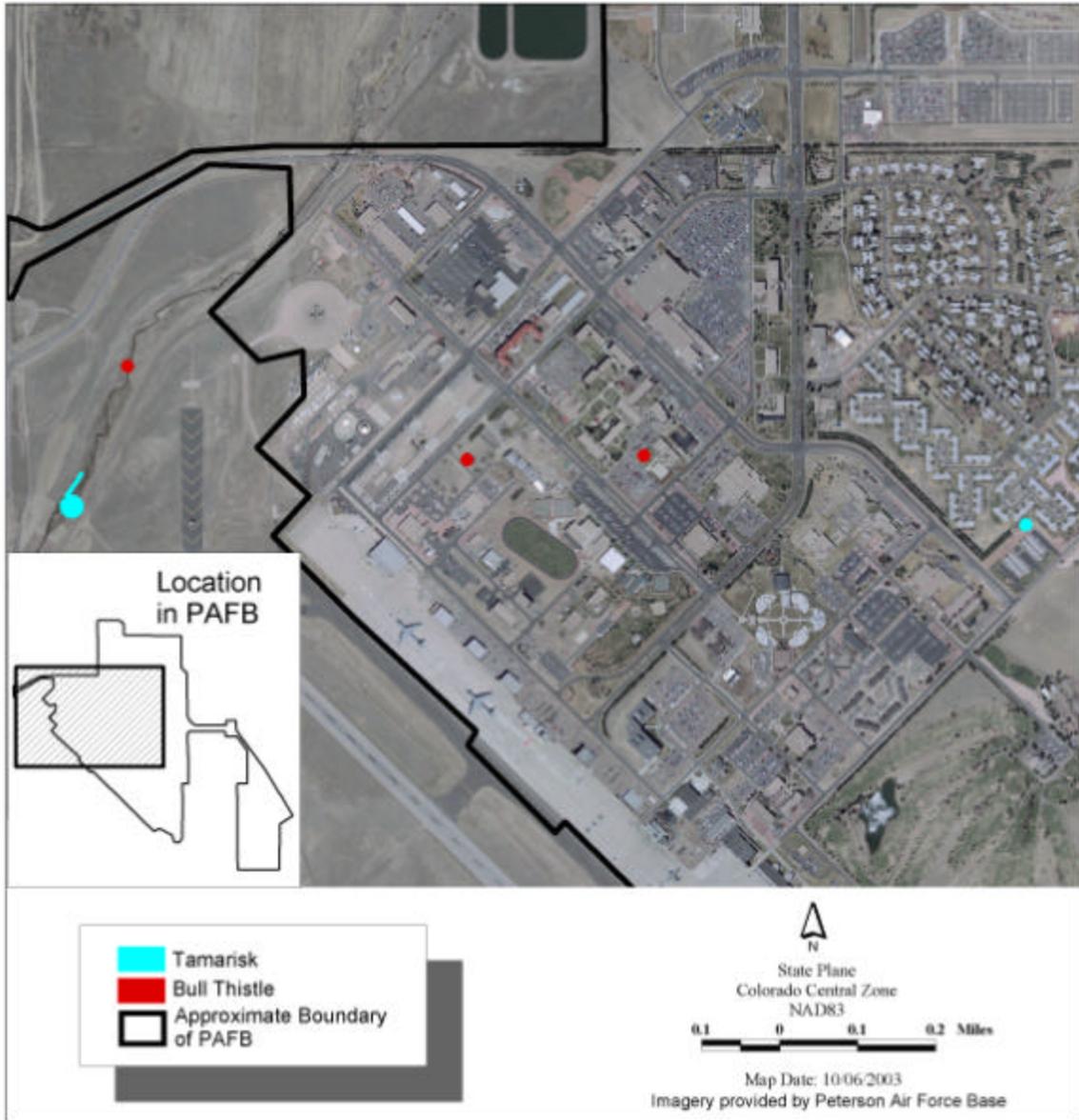


Figure 7. Puncturevine occurrences at PAFB

Puncturevine (*Tribulus terrestris*)

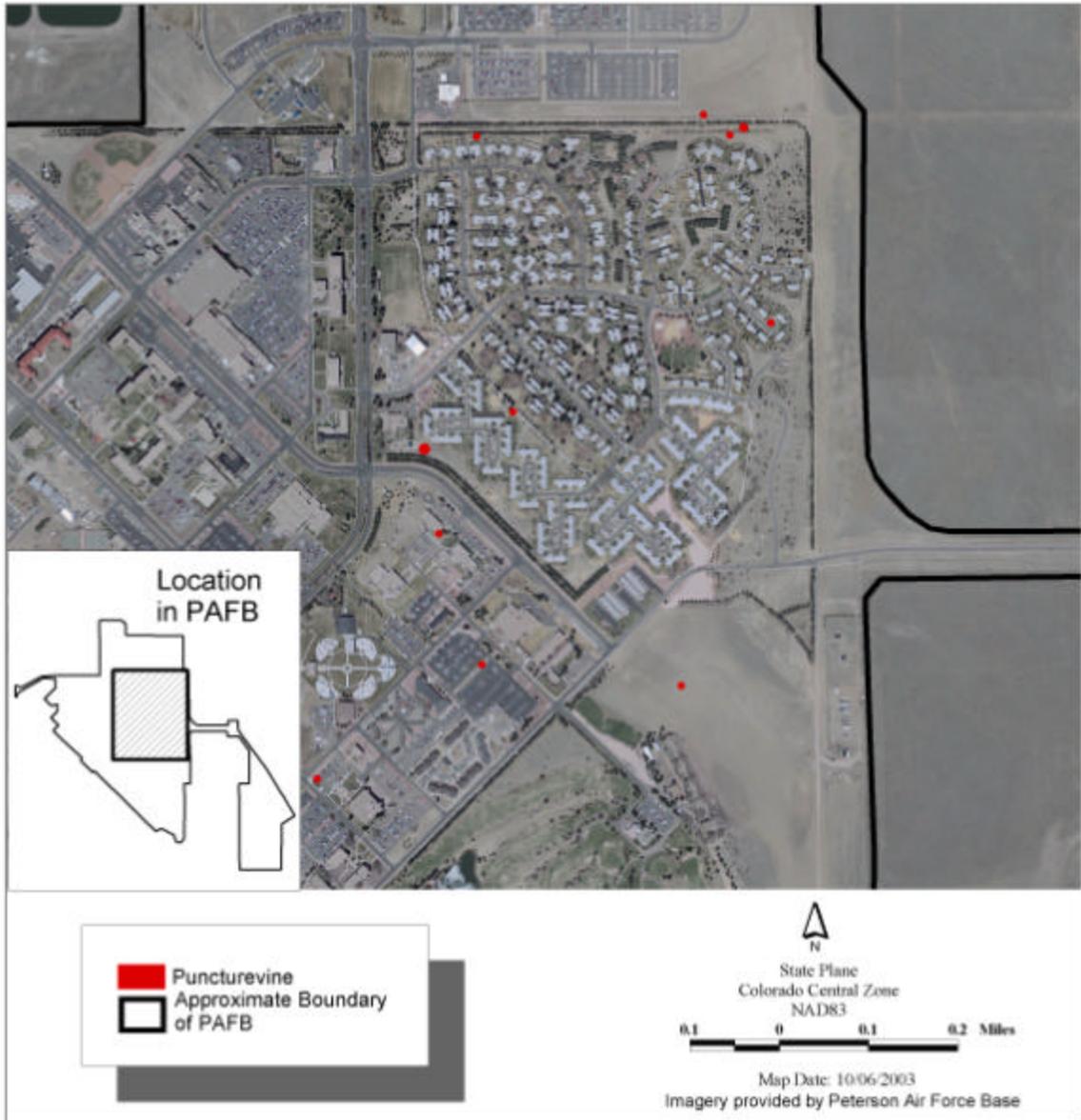


Figure 8. Common St. Johnswort occurrences at PAFB

Common St. Johnswort (*Hypericum perforatum*)

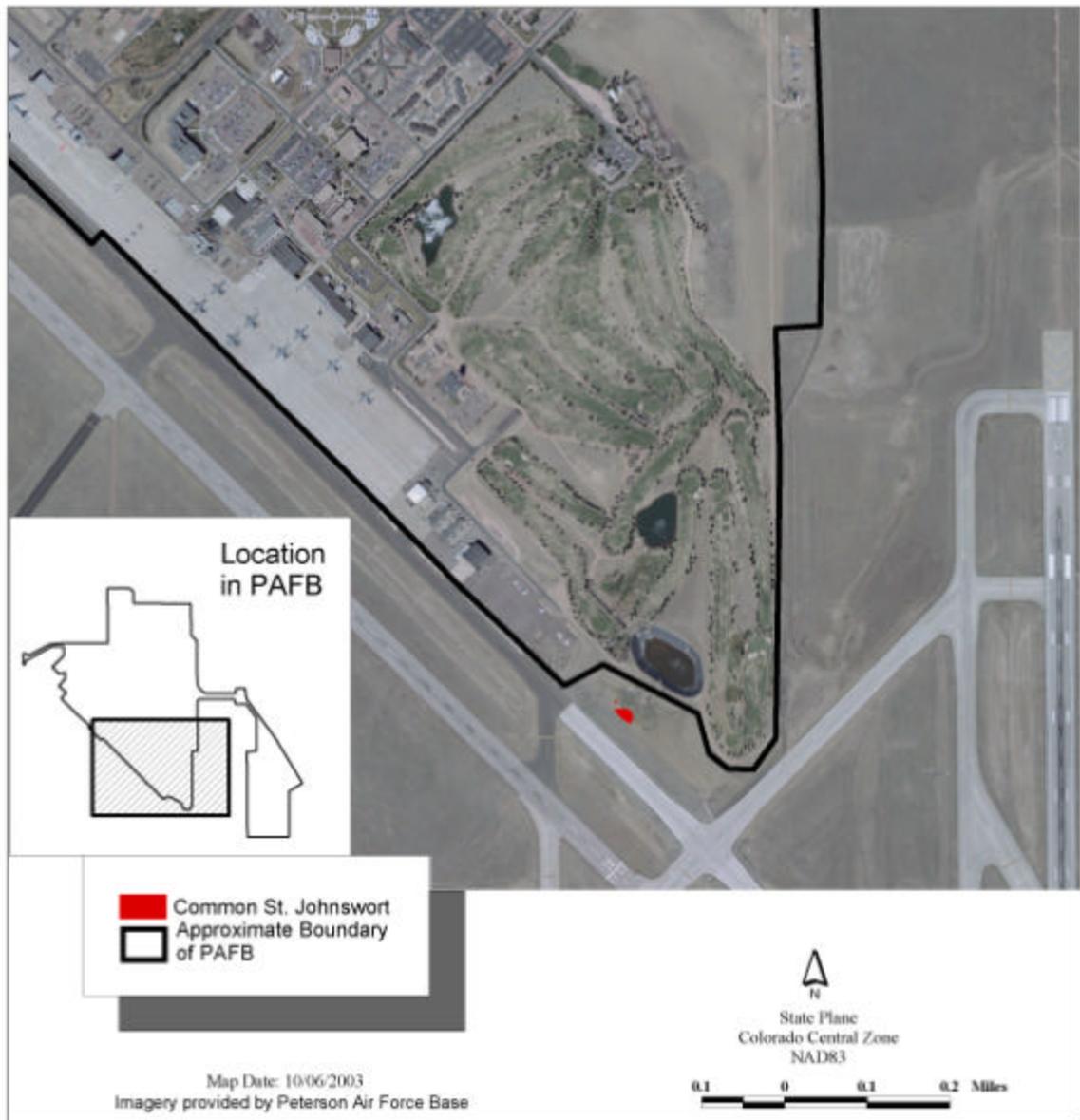


Figure 9. Baby's breath, yellow toadflax, purple loosestrife and bouncingbet occurrences at PAFB

Baby's Breath (*Gypsophila paniculata*), **Purple Loosestrife** (*Lythrum salicaria*)
Bouncingbet (*Saponaria officinalis*), and **Yellow Toadflax** (*Linaria vulgaris*)

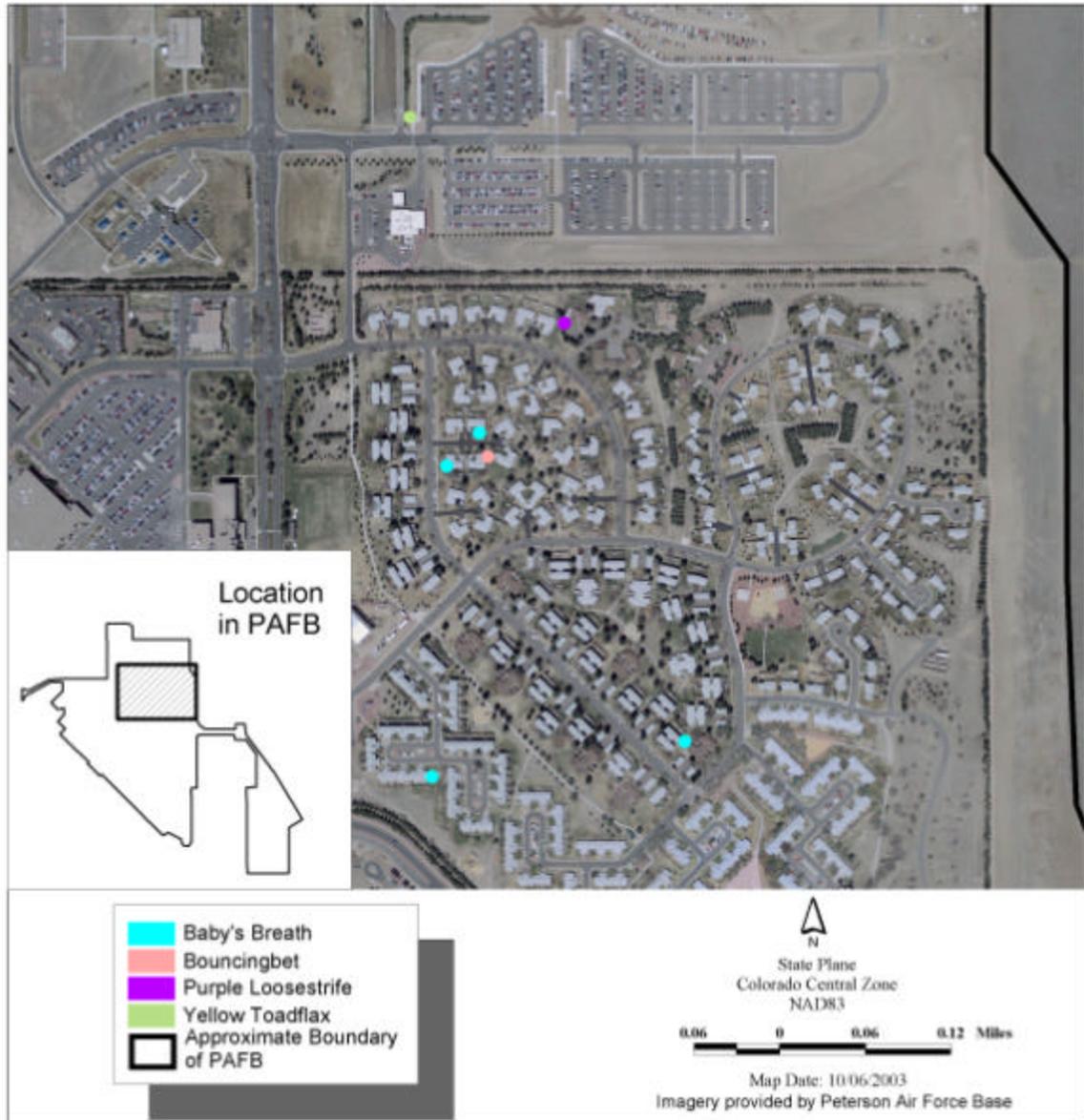


Figure 10. Headquarters, Air Force Space Command (Hartinger Building) noxious weed occurrences

Headquarters, Air Force Space Command (Hartinger Building) Noxious Weed Occurrences

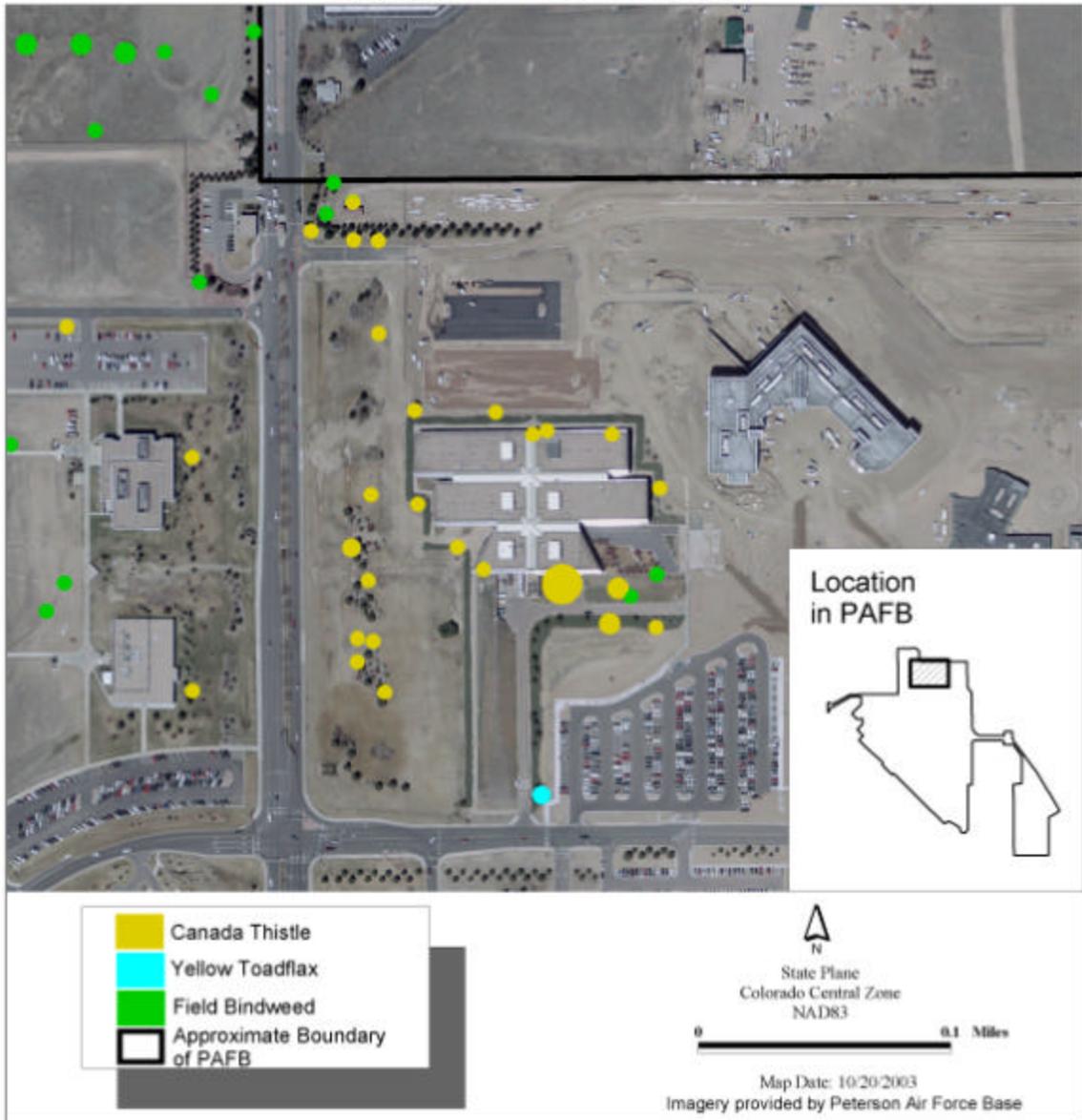


Figure 11. Future Recreation Center Site, West of North Entrance noxious weed occurrences

Future Recreation Center Site, West of North Entrance Noxious Weed Occurrences

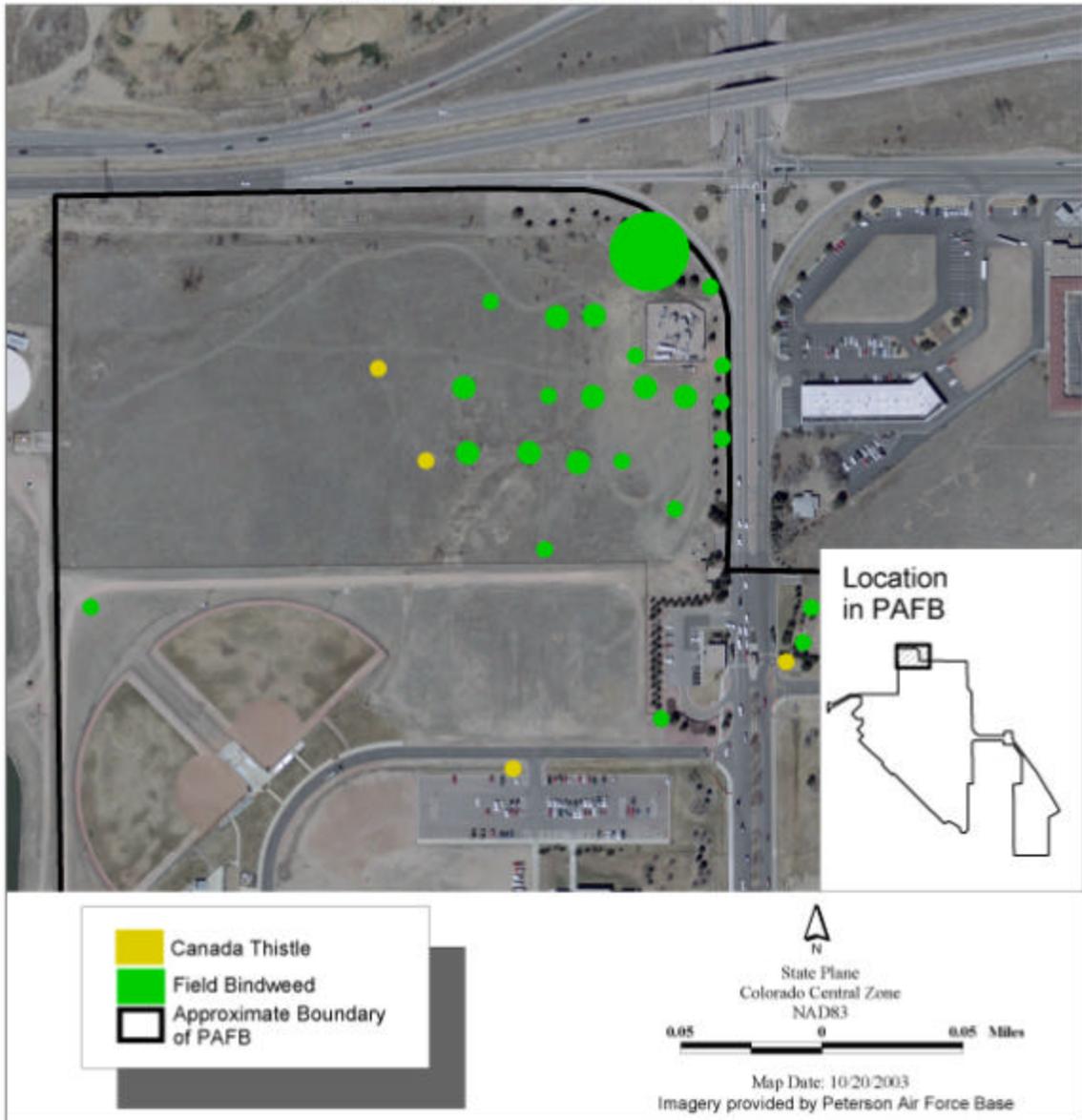


Figure 12. Hamilton Avenue noxious weed occurrences

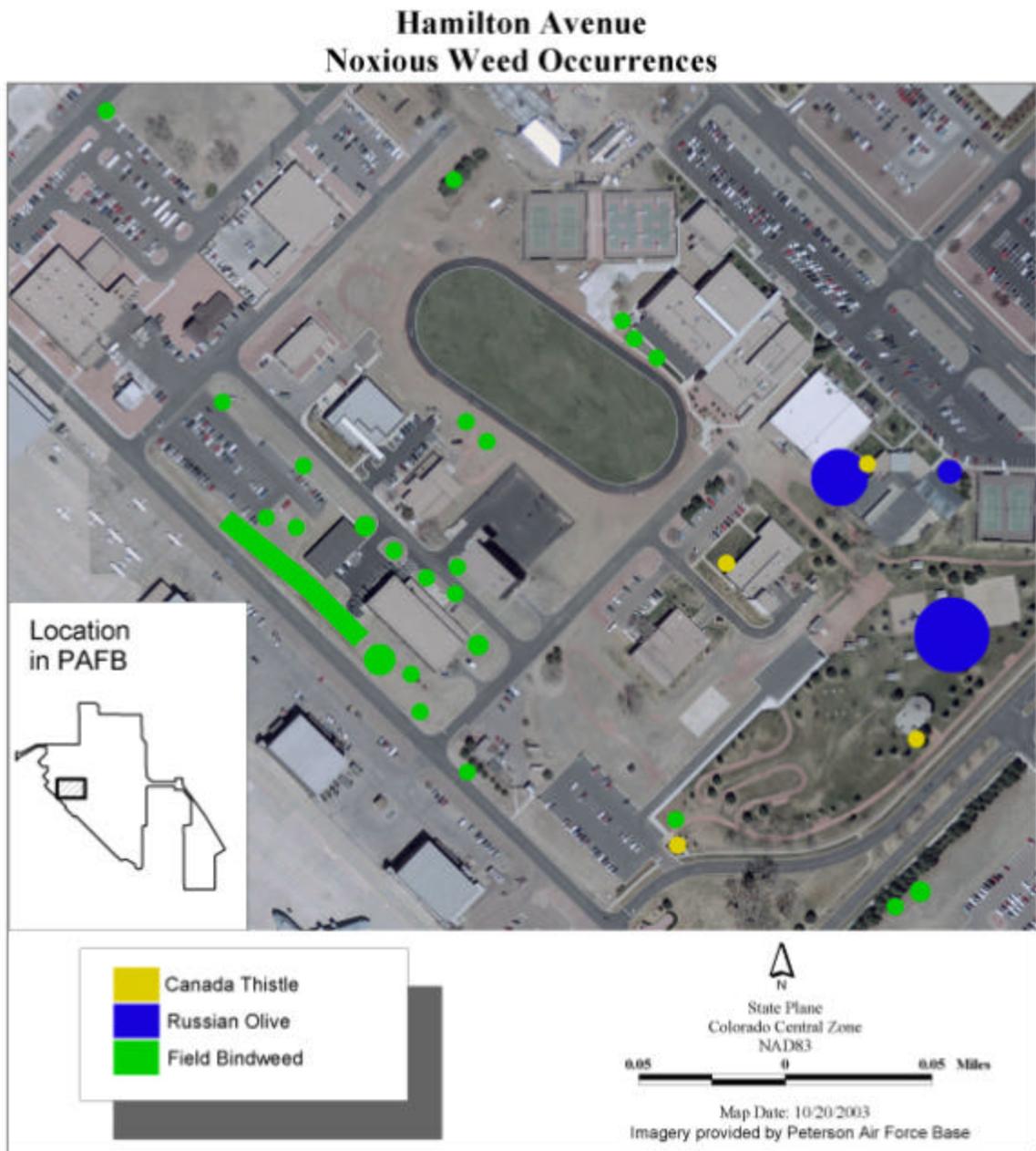
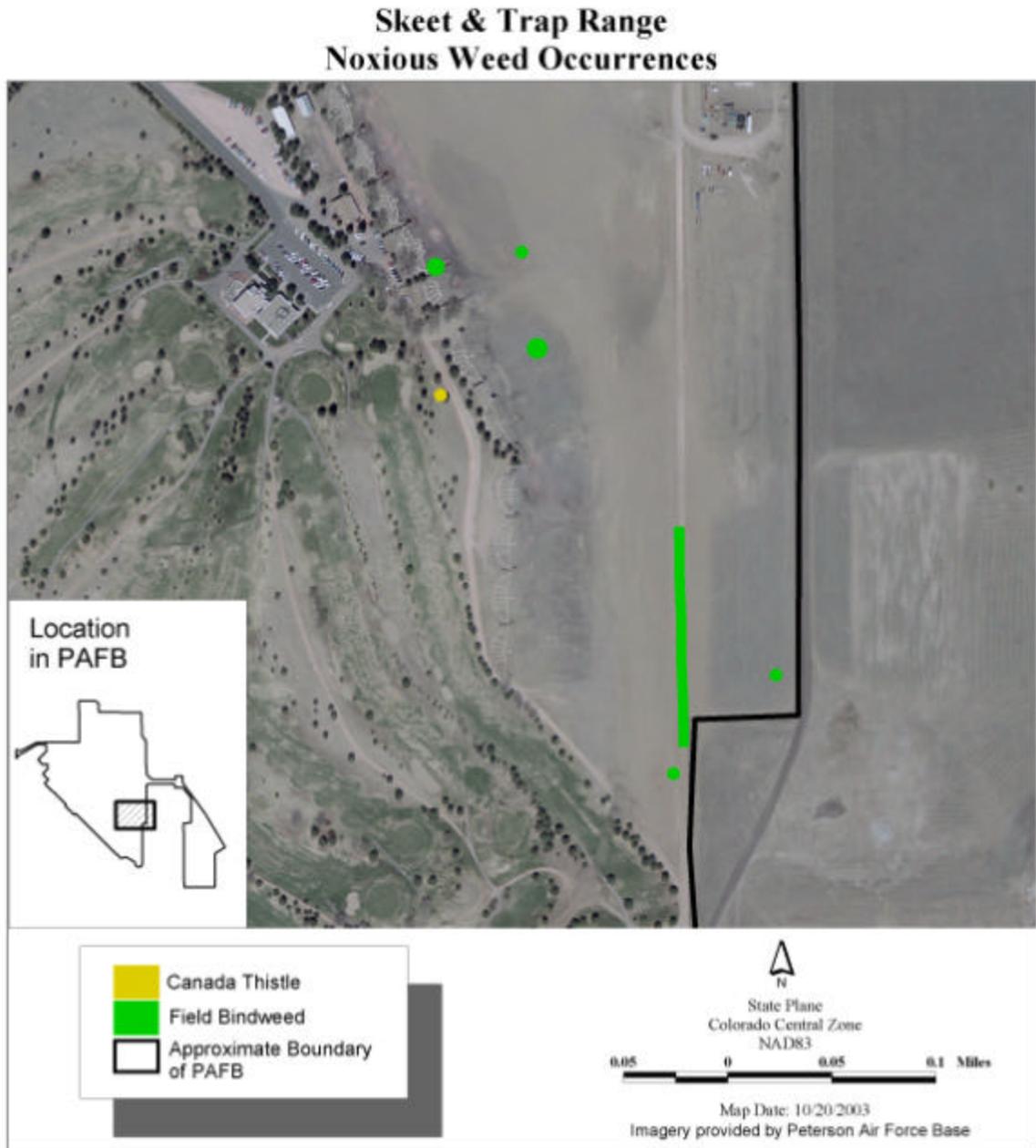


Figure 13. Skeet and Trap Range noxious weed occurrences



APPENDIX 2: DATA MANAGEMENT PROCEDURES

File Structure

Each geographic file is provided in ArcView shapefile format and Arc/Info export format (pafb_weeds.shp and pafb_weeds.e00). Both files are projected to the State Plane Coordinate System, Colorado central zone, North American Datum of 1983 (NAD83). Map units are feet. FGDC (Federal Geographic Data Committee) compliant metadata (version of June 8, 1994) are provided as an ASCII text file (pafb_weeds.met). These files are located in the GIS folder on the CD.

Data Capture and Processing

ArcPad 6.0.2 (ESRI 1995-2003), installed on a PDA connected to a Teletype GPS, was used to capture point, line and polygon noxious weed occurrences in the field. Attribute information was captured via field forms prepared in ArcPad Studio 6.0 (ESRI 2002). WAAS was enabled to differentially correct the data “on the fly”. WAAS results in <3m of error 95% of the time. The system was modified to warn the user when the Position Dilution of Precision (PDOP) exceeded 6 or when the Estimated Position Error (EPE) exceeded 8. Data were not captured if these thresholds were met or exceeded.

To prevent data loss, weed occurrences were mapped into empty shapefiles daily and backed-up on a laptop and compact disk. Points were buffered by the radius documented in the field and lines were buffered by the buffer distance and buffer direction documented in the field. Since the GPS is accurate to within 3m, the minimum mapping unit was set to 3m (that is, since the mapped location can be off by 3m in any direction, radii and buffer distances are never less than 3m). All files were merged and topology was built using ArcGIS 8.1 (ESRI 1987-2003). For delivery to PAFB, the Arc/Info coverage was converted to an ArcView shapefile. Since there are a few locations in which noxious weed species co-occur, the files are provided as regions (overlapping or grouped polygons), in subclass data (hence, attribute information for the Arc/Info coverage is stored in .patdata; see Arc/Info help for more information on regions). Refer to the metadata accompanying this report for more information.

APPENDIX 3. WEED FEATURE TYPES

Data were captured as points, lines or polygons in the field. Points were mapped for small or circular weed occurrences and a radius was assigned (Figure 14). Lines were mapped for linear occurrences (Figure 15) and a buffer distance and direction were assigned (direction refers to the topological direction, that is, the direction the observer was walking while in the field). Points and lines were buffered and combined with polygons to generate one polygon coverage, reflecting the gross area of the weed infestations at PAFB.

Figure 14. Converting point weed occurrences to polygons

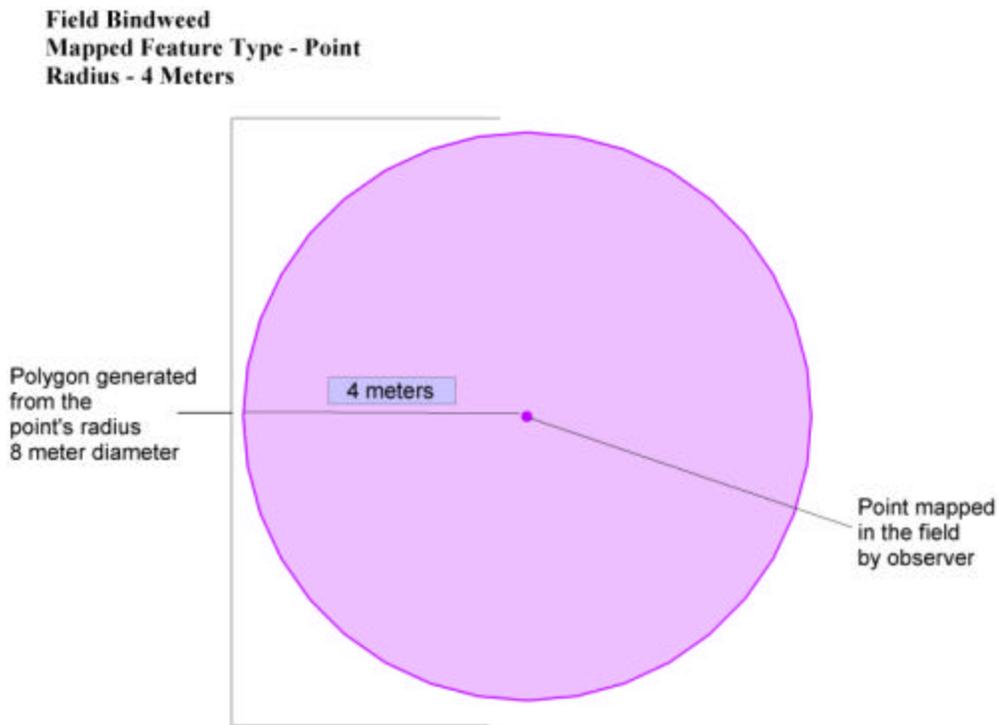


Figure 15. Converting line weed occurrences to polygons

Field Bindweed
Mapped Feature Type - Line
Buffer Distance - 10 Meters
Buffer Direction - Right

