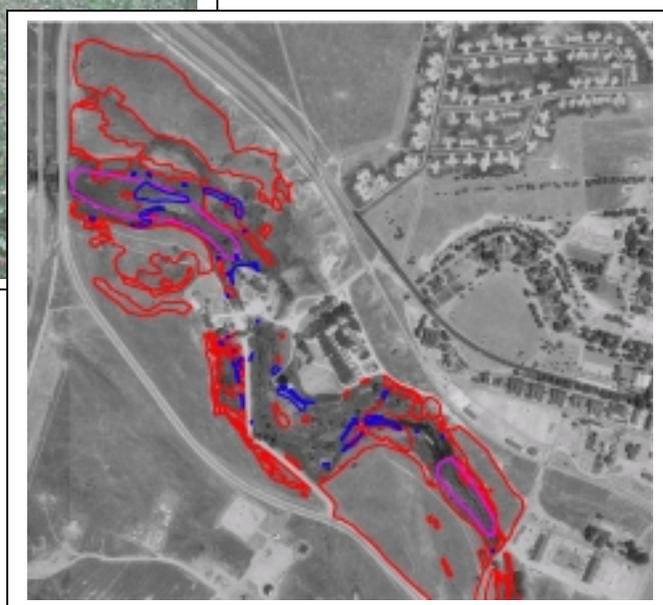


Distribution of Noxious Weeds
Within the Habitat of
Threatened Plant and Animal Species
on F.E. Warren Air Force Base



Prepared for the US Air Force by:

Walter Fertig and Melanie Arnett
Wyoming Natural Diversity Database
University of Wyoming
PO Box 3381
Laramie, WY 82071

28 February 2001

Contract # F4860800W0040

TABLE OF CONTENTS

	<u>Page</u>
Introduction	4
Methods	4
Study Area	4
1999 Predicted Distribution Map	6
2000 Field Mapping	6
Results	8
Discussion	8
Weed Distribution and Rare Species	8
Modeling vs Field Mapping	10
Conclusions	11
Acknowledgements	11
Literature Cited	11

Figures, Tables, and Appendices

Figure

1. General location of Colorado butterfly plant and Preble’s meadow jumping mouse populations on F.E. Warren Air Force Base.	5
2. Weed-mapping areas on F.E. Warren Air Force Base	7
3. Distribution of Canada thistle and rare plant and animal species along upper Crow Creek	14
4. Distribution of Canada thistle and rare plant and animal species along middle Crow Creek	15
5. Distribution of Canada thistle and rare plant and animal species along Diamond Creek	16
6. Distribution of Canada thistle and rare plant and animal species along the Unnamed drainage	17
7. Distribution of Common hound’s tongue and rare plant and animal species along upper Crow Creek	18
8. Distribution of Common hound’s tongue and rare plant and animal species along middle Crow Creek	19
9. Distribution of Common hound’s tongue and rare plant and animal species along Diamond Creek	20

10. Distribution of Common hound’s tongue and rare plant and animal species along the Unnamed drainage	21
11. Distribution of Leafy spurge and rare plant and animal species along upper Crow Creek	22
12. Distribution of Leafy spurge and rare plant and animal species along middle Crow Creek	23
13. Distribution of Leafy spurge and rare plant and animal species along Diamond Creek	24
14. Distribution of Leafy spurge and rare plant and animal species along the Unnamed drainage	25
15. Distribution of Dalmatian toadflax and rare plant and animal species along upper Crow Creek	26
16. Distribution of Dalmatian toadflax and rare plant and animal species along middle Crow Creek	27
17. Distribution of Dalmatian toadflax and rare plant and animal species along Diamond Creek	28
18. Distribution of Dalmatian toadflax and rare plant and animal species along the Unnamed drainage	29
19. Distribution of Purple loosestrife and rare plant and animal species along upper Crow Creek	30

Table

1. Abundance of noxious weed species along Crow and Diamond creeks and the Unnamed drainage	9
---	---

Appendix

A. Non-native plant species of F.E. Warren Air Force Base	31
B. Noxious weeds of F.E. Warren Air Force Base	34
Canada thistle	35
Common hound’s tongue	36
Leafy spurge	37
Dalmatian toadflax	38
Purple loosestrife	39

Cover Images (left to right): Dense Canada thistle patch by “No Mowing” sign along the Unnamed drainage. Photo by Walter Fertig, 1 September 1999. Map of Canada thistle distribution along Upper Crow Creek.

INTRODUCTION

F.E. Warren Air Force Base (WAFB) provides habitat for several state or regionally rare animal and plant species, including the federally Threatened Preble's meadow jumping mouse (*Zapus hudsonius preblei*) and Colorado butterfly plant (*Gaura neomexicana* ssp. *coloradensis*) (Fertig 1995, 2001; Keinath 2001). Among the many threats to these species are competition and habitat degradation resulting from the invasion of non-native plants. Statewide, approximately 350 plant taxa are considered non-native (12.6% of the total flora), of which 67 occur on WAFB (Appendix A) (Easter and Douglas 1996; Hazlett 1999; Fertig 1999a). Five non-native plants (Canada thistle, Common hound's tongue, Leafy spurge, Dalmatian toadflax, and Purple loosestrife) are of particularly high management concern because of their ability to invade riparian and floodplain areas occupied by the Base's rarest plant and animal taxa.

Beginning in 1999, the US Air Force contracted with University of Wyoming and the Wyoming Natural Diversity Database (WYNDD) to map the distribution of these five noxious weed species in the Crow and Diamond creek watersheds. Hiemstra and Fertig (2000) produced a series of predicted weed distribution maps based on limited Global Positioning System (GPS) field mapping and extrapolations using a computerized modeling algorithm and digital orthophoto images of the Base. In September 2000, these predictive maps were ground-truthed and revised with new ocular and GPS data. The results of this new mapping effort are discussed in the following report.

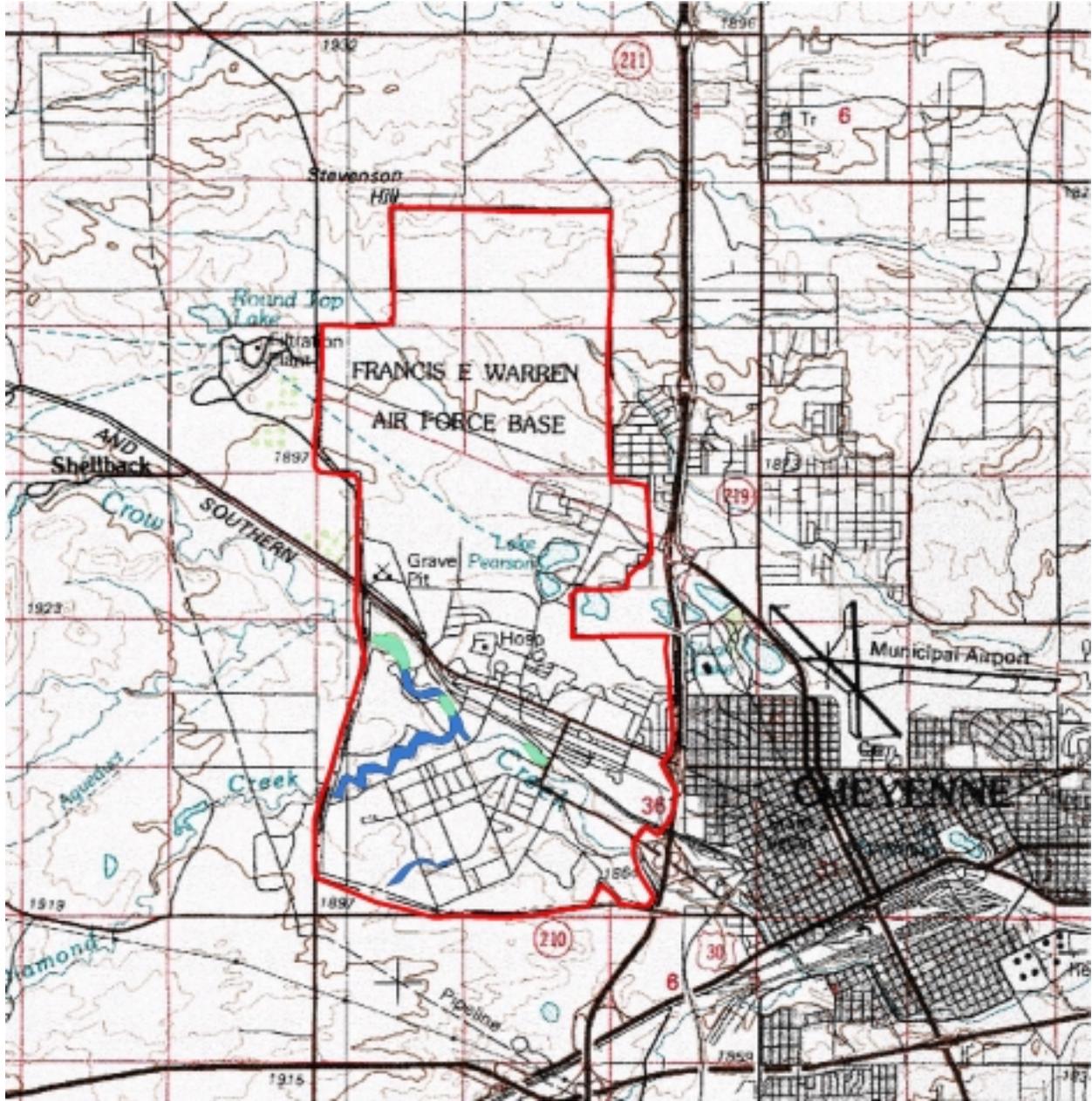
METHODS

Study Area

Mapping was restricted to the known range of Colorado butterfly plant within the 100-year floodplain of Crow and Diamond creeks and the "unnamed drainage" (an ephemeral tributary of Crow Creek) on WAFB (Figures 1-2). Riparian areas within the floodplain are a mosaic of Coyote willow/Strapleaf willow thickets (*Salix exigua*/*S. eriocephala* var. *ligulifolia*), Green ash/Lanceleaf cottonwood woodlands (*Fraxinus pennsylvanica*/*Populus x acuminata*), Cattail marshes (*Typha latifolia*), Nebraska sedge/Woolly sedge wetlands (*Carex nebrascensis*/*C. lanuginosa*), and moist meadows of Redtop (*Agrostis stolonifera*), Baltic rush (*Juncus balticus*), Kentucky bluegrass (*Poa pratensis*), Little bluestem (*Schizachyrium scoparium*), and Licorice-root (*Glycyrrhiza lepidota*). Drier upland areas have scattered patches of ash and cottonwood or grasslands of Blue grama (*Bouteloua gracilis*), Kentucky bluegrass, Western wheatgrass (*Elymus smithii*), or Needle-and-thread (*Stipa comata*) (Marriott and Jones 1988). Extensive areas in both the uplands and riparian zone are currently dominated by Canada thistle, Leafy spurge, Dalmatian toadflax, and Crested wheatgrass, with Common hound's tongue also often locally abundant.

Figure 1. General Location of Colorado Butterfly Plant and Preble's Meadow Jumping Mouse Populations on F.E. Warren Air Force Base.

 Colorado butterfly plant  Preble's meadow jumping mouse
Note: Both species overlap at the far northeastern end of Crow Creek.



1999 Predicted Distribution Map

In 1999, field mapping was limited to the upper reach of Crow Creek (north of the FamCamp access road) and the westernmost bend of Diamond Creek. Within these areas, all discrete patches of the 5 target weed species were mapped using a Trimble GeoExplorer® II GPS. The perimeter of each patch was traversed on foot, with the GPS recording positions at approximately 15 second intervals. Each polygon mapped in the field was attributed with the names of the weed species present in the patch. These data were differentially corrected using Trimble's Pathfinder Office™ (v. 2.11, 1999) software and data from the University of Wyoming/BLM Casper Field Office base station in Casper, Wyoming. Once corrected, the data were exported into Arc-Info® Geographical Information System (GIS) on a Unix® Workstation for processing and analysis.

To create the predicted distribution maps, individual polygons were overlaid onto digital orthophotograph images of WAFB available from the University of Wyoming's Spatial Data and Visualization Center (<http://www.sdvc.uwyo.edu>). The arc and orthophoto coverages were converted to grid format in Arc-view® and color-coded using a grayscale of 255 units. A query command was used to identify the subset of grayscale colors that were positively associated with the GPS-mapped distribution of each weed species. In Arc-Info, the Describe command was used to determine the average numeric value (DN) and standard deviation (SD) of the selected grayscale colors. Using this information, the entire study area was reclassified for each target species using the formula:

$$\text{extrapolated DN range} = \text{average DN} \pm \frac{1}{2} \text{SD}. \quad (1)$$

All grayscale values falling within the extrapolated DN range were selected in Arc-Info to represent the potential distribution of the target species. Distribution maps (Figures 5-8 in Hiemstra and Fertig 2000) were created in Arc-view by overlaying the selected grid cells on the orthophoto base image.

2000 Field Mapping

The 100-year floodplain area of Crow and Diamond creeks from the Base boundary to the 6th Street Bridge and the Unnamed drainage were remapped by Walter Fertig and Melanie Arnett of WYNDD on 8-14 September 2000 (Figure 2). All discrete patches of Canada thistle, Common hound's tongue, Leafy spurge, and Dalmatian toadflax were mapped by hand on 1:75 scale 8 1/2 x 11 enlargements of the digital orthophotos for the Base. Populations that could not be reliably placed on the photos were mapped with a Garmin™ Etrex GPS unit. Each polygon was attributed with information on the weed species present and their relative cover. Additional notes were taken on the distribution of Colorado butterfly plant. Polygons were hand digitized into Arc-view GIS using digital orthophoto images as a base layer. Final distribution maps were produced at a scale of 1:260.

Figure 2.
Weed-mapping areas on F.E. Warren Air Force Base



RESULTS

The 1999 modeling study identified 114 hectares (46.2 acres) of potential noxious weed habitat within a 108 hectare study area in the 100-year floodplain of Crow and Diamond creeks (Hiemstra and Fertig 2000). Canada thistle (*Cirsium arvense*) was predicted to be the most widespread weed species within the study site, occupying an area of 33.9 ha (83.8 acres) or 32% of the total area (Table 1). Common hound's tongue (*Cynoglossum officinale*) was mapped in much of the same habitat as Canada thistle, but was predicted to occur in only 27.1 ha (67.1 acres) or 25% of the area. The extrapolated distribution of Leafy spurge (*Euphorbia esula*) covered 23.1 ha (57.1 acres), or 21% of the study site. Lastly, Dalmatian toadflax (*Linaria dalmatica*) was predicted to occupy 29.7 ha (73.3 acres), or 28% of the study area. No extrapolations were made of the distribution of Purple loosestrife (*Lythrum salicaria*) due to insufficient location information.

Mapping in 2000 focused on a smaller area of riparian habitat on Crow and Diamond creeks (67.4 ha) and an 11 ha buffer around the Unnamed drainage that was not modeled in 1999. As predicted, Canada thistle was the most pervasive noxious weed in the study area, occupying 31.3 ha (12.7 acres) or nearly 40% of the mapped area (Table 1, Figures 3-6). Dalmatian toadflax was the second most widespread weed species, occurring over 24.9 ha (10.1 acres) or nearly 32% of the study area (Table 1, Figures 15-18). Leafy spurge was mapped in 16.6 ha (6.7 acres), or 21.2% of the area (Table 1, Figures 11-14). Common hound's tongue proved to be the least abundant weed species, occurring in 11.8 ha (4.8 acres) or 15% of the mapped area (Table 1, Figures 7-10). Overall, these 4 weed species occupied 84.6 ha (34.3 acres).

Purple loosestrife was not encountered in the 2000 survey and may be extirpated from the Base. The location of the last known population is mapped in Figure 19 (Fertig 1999b).

DISCUSSION

Weed Distribution and Rare Species

Field mapping in 2000 confirmed the general predictions of the 1999 weed model that most of the riparian and upland meadow habitat within the 100-year floodplain of the Crow/Diamond Creek and Unnamed drainage watersheds is occupied by noxious weed species. Although the size of the area used in the modeling exercise differed from the area that which was actually mapped, the overall percentages of the study site occupied by Canada thistle, Leafy spurge, and Dalmatian toadflax were approximately equal. Only the Common hound's tongue model overestimated its actual range in the watershed (the observed percentage of occupied area was 9.9% less than the predicted value). Hound's tongue probably does not occur in all of its potential habitat due to competition from Canada thistle and its inability to spread vegetatively.

Although Colorado butterfly plant co-occurs with all 5 noxious weed species, colonies of *Gaura* tend to be negatively correlated with large weed patches. Based on an intersection of polygons, only 25.1% of the riparian area occupied by Colorado butterfly plant overlaps with large patches of Canada thistle (Figures 4-7). Even lower percentages of occupied *Gaura* habitat are shared with dense populations of Leafy spurge (20.3%), Dalmatian toadflax (11.5%), or Common

Table 1.
Abundance of Noxious Weed Species Along Crow and Diamond Creeks
and the Unnamed drainage

	Canada thistle	Common Hound's tongue	Leafy spurge	Dalmatian toadflax
1999 Predicted Area (hectares)	83.8	67.1	57.1	73.3
1999 Predicted Area (acres)	33.9	27.2	23.1	29.7
1999 Predicted % of Total Area*	32	25	21	28
2000 Mapped Area (hectares)	31.3	11.8	16.6	24.9
2000 Mapped Area (acres)	12.7	4.8	6.7	10.1
2000 Mapped % of Total Area**	39.9	15.1	21.2	31.8
Number of Polygons	318	185	134	125

* The total area modeled in 1999 was 107.7 hectares and was limited to Crow and Diamond creeks.

** The total area mapped in 2000 was 78.4 hectares and included 11.0 hectares along the Unnamed drainage which was not modeled in 1999.

No populations of Purple loosestrife were observed during field surveys in 1999 and 2000. The single known population on WAFB may have been extirpated in September 1998 following manual removal of all above-ground shoots and underground roots and soil.

hound's tongue (10.4%). In combination, however, large patches of noxious weeds co-occur with butterfly plant over 67% of its range on WAFB. The dominance of noxious weeds at many riparian sites may also be preventing Colorado butterfly plant from occupying the full extent of its available habitat because of competition for water, light, soil nutrients, and space (Fertig 2001).

Past capture localities and the presumed range of Preble's meadow jumping mouse on WAFB also overlap with the distribution of large patches of Canada thistle, Leafy spurge, and Dalmatian toadflax (Figures 3-4, 11-12, 15-16). Beauvais (1998) noted that the full effects of noxious weeds on Preble's meadow jumping mouse are poorly understood. Previous studies in Colorado have suggested that jumping mice are more dependent on the amount of vegetative cover rather than its species composition. Garber (1995) however, suggested that the displacement of the native flora by introduced weeds may be reducing the amount of food available to the jumping mouse population on the Base.

Modeling vs. Field Mapping

Our field mapping in 2000 corroborated most of the predictions made by the weed model of Hiemstra and Fertig (2000). The primary differences between the models and field observations had to do with overestimation of cover for Common hound's tongue and local overestimation of Leafy spurge in the upland areas of upper Crow Creek. Recent soil removal activities on the north side of Diamond Creek prevented these areas from being mapped in 2000, accounting for the apparent mismatch between the models and maps.

The primary advantage of modeling the distribution of weed species is that it is potentially less labor intensive than traditional manual mapping. Ideally, a network of randomly located sampling points (measured with GPS) could be used to extrapolate the distribution of target species. In addition to using the gray-scale patterns from digital orthophotos, models could be constructed using local or regional digital environmental datasets for temperature, precipitation, bedrock geology, soil type, land cover, topography, and elevation. Statistical tools, including logistic regression and classification tree analysis are available to quantify spatial patterns in the presence and absence of target species (Frankin 1995; Fertig 2000).

Mapping with GPS units offers the advantage of high spatial accuracy (within 4 meters horizontally). Digital GPS data can be combined with other spatial data layers to answer a variety of management questions. GPS mapping can be very slow, however, especially if vegetation and terrain conditions interfere with satellite reception. Our initial efforts to map the entire Crow and Diamond creek watersheds with GPS in 1999 had to be abandoned because of time constraints.

In 2000, we found high-resolution enlargements of digital orthophotos to be a useful tool for relatively rapid manual mapping of large weed patches in the field. Terrain features could be easily located on these images, allowing a trained mapper to cover ground more quickly than someone using a GPS. One drawback of this technique, however, is the greater probability for error in the subjective location of polygons or in transcribing the polygons to GIS.

Conclusions

Our mapping illustrates the seriousness of the noxious weed problem in floodplain areas of F.E. Warren Air Force Base. New weed species continue to arrive on the Base, and several (especially Cicer milkvetch [*Astragalus cicer*] and Yellow sweetclover [*Melilotus officinalis*]) show signs of rapid expansion. Future weed mapping and control efforts may need to be expanded to include these new species. The use of actual and predicted weed distribution maps will hopefully assist land managers prioritize where weed control efforts should take place and might serve as a baseline to assess future changes in weed distribution.

ACKNOWLEDGEMENTS

We wish to thank Tom Smith of F.E. Warren Air Force Base for his assistance with this project and Chris Hiemstra, Rebekah Smith, and Robert Thurston of the University of Wyoming Botany Department and WYNDD for providing technical assistance with Arc-view and modeling.

LITERATURE CITED

Beauvais, G.P. 1998. Survey for Preble's meadow jumping mouse (*Zapus hudsonius preblei*) on F.E. Warren Air Force Base, Wyoming, September 1998. Report prepared for the US Air Force by the Wyoming Natural Diversity Database, Laramie, WY.

Cronquist, A., A.H. Holmgren, N.H. Holmgren, J.L. Reveal, and P.K. Holmgren. 1984. Vol. 4: Subclass Asteridae (excluding Asteraceae). Intermountain Flora: Vascular Plants of the Intermountain West, USA. New York Botanical Garden, Bronx, NY.

Cronquist, A., N.H. Holmgren, and P.K. Holmgren. 1997. Volume 3, Part A. Subclass Rosidae (except Fabales). Intermountain Flora, Vascular Plants of the Intermountain West, USA. New York Botanical Garden, Bronx, NY.

Dorn, R.D. 1992. Vascular Plants of Wyoming, second edition. Mountain West Publ., Cheyenne, WY.

Easter, M.J. and P.P. Douglas. 1996. Floristic survey of F.E. Warren Air Force Base, Wyoming. Center for Ecological Management of Military Lands, Dept. of Forest Sciences, Colorado State University, Ft. Collins, CO.

Fertig, W. 1995. Rare plants of F.E. Warren Air Force Base, Cheyenne, Wyoming. Report prepared for the US Air Force by the Wyoming Natural Diversity Database, Laramie, WY.

Fertig, W. 1999a. Non-native plants of Wyoming. *Castilleja* 18(2):7-10.

Fertig, W. 1999b. Purple loosestrife (*Lythrum salicaria*) on F.E. Warren Air Force Base. Report prepared for the US Air Force by the Wyoming Natural Diversity Database, Laramie, WY.

Fertig, W. 2000. Predictive modeling of rare plant species. *Gap Analysis Bulletin* 8:18-19.

Fertig, W. 2001. 2000 census of Colorado butterfly plant (*Gaura neomexicana* ssp.

coloradensis) on F.E. Warren Air Force Base. Report prepared for the US Air Force by the Wyoming Natural Diversity Database, Laramie, WY.

Franklin, J. 1995. Predictive vegetation mapping: geographic modelling of biospatial patterns in relation to environmental gradients. *Progress in Physical Geography* 19:474-499.

Garber, C. 1995. A status survey for Preble's meadow jumping mouse (*Zapus hudsonius preblei*) in southeastern Wyoming, including the F.E. Warren Air Force Base. Report prepared for the Wyoming Natural Diversity Database.

Gleason, H.A. and A. Cronquist. 1991. *Manual of the Vascular Plants of Northeastern United States and Adjacent Canada*, second edition. New York Botanical Garden, Bronx, NY.

Great Plains Flora Association. 1986. *Flora of the Great Plains*. University Press of Kansas, Lawrence, KS.

Hazlett, D.L. 1999. Plant biochemical/plant use inventory F.E. Warren Air Force Base, Wyoming. Report prepared for the US Air Force by New World Plants and People, Pierce, CO.

Hiemstra, C. and W. Fertig. 2000. The distribution of noxious weeds on F.E. Warren Air Force Base. Report prepared for the US Air Force by the Wyoming Natural Diversity Database, Laramie, WY.

Hight, S.D. and J.J. Drea, Jr. 1991. Prospects for a classical biological control project against purple loosestrife (*Lythrum salicaria* L.). *Natural Areas Journal* 11(3): 151-157.

Keinath, D.A. 2001. Survey for Preble's meadow jumping mouse (*Zapus hudsonius preblei*) on F.E. Warren Air Force Base, Cheyenne, Wyoming. Report prepared by the Wyoming Natural Diversity Database, Laramie, WY.

Marriott, H. and G. Jones. 1988. Preserve design package for a proposed Colorado butterfly plant Research Natural Area on F.E. Warren Air Force Base. Report prepared for the US Air Force by the Wyoming Natural Diversity Database, Laramie, WY.

Thompson, D.Q., R.L. Stuckey, and E.B. Thompson. 1987. Spread, impact, and control of purple loosestrife (*Lythrum salicaria*) in North American wetlands. Fish and Wildlife Service Research No. 2. US Department of Interior, Washington, DC.

Welsh, S.L., N.D. Atwood, S. Goodrich, and L.C. Higgins. 1993. *A Utah Flora*, second edition, revised. Brigham Young University, Provo, UT.

Whitson, T.D., L.C. Burrill, S.A. Dewey, D.W. Cudney, B.E. Nelson, R.D. Lee, and R. Parker. 1991. *Weeds of the West*. Western Society of Weed Science, Western United States Land Grant Universities Cooperative Extension Service, and the University of Wyoming.

Wilson, R.G. 1981. Effect of Canada thistle (*Cirsium arvense*) residue on growth of some crops. *Weed Science* 29:159-164.

Figure 3. Distribution of Canada thistle and Rare Plant and Animal Species Along Upper Crow Creek

 Canada thistle  Colorado butterfly plant  Preble's meadow jumping mouse



Figure 4. Distribution of Canada thistle and Rare Plant and Animal Species Along Middle Crow Creek

 Canada thistle  Colorado butterfly plant  Preble's meadow jumping mouse



Figure 5. Distribution of Canada thistle and Rare Plant and Animal Species Along Diamond Creek

Canada thistle Colorado butterfly plant Preble's meadow jumping mouse

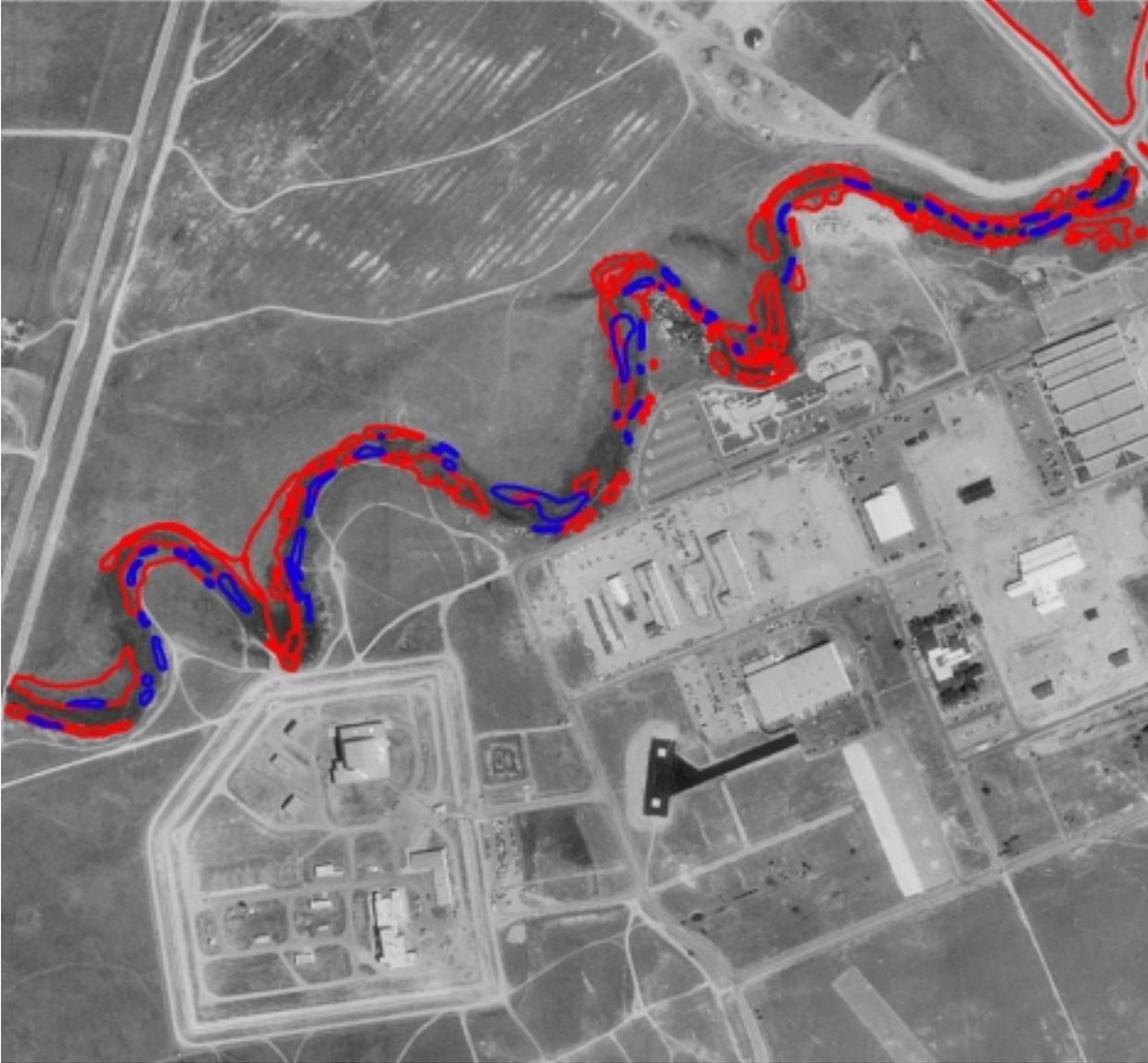


Figure 6. Distribution of Canada thistle and Rare Plant and Animal Species Along the Unnamed Drainage

Canada thistle Colorado butterfly plant Preble's meadow jumping mouse



Figure 7. Distribution of Common hound's tongue and Rare Plant and Animal Species Along Upper Crow Creek

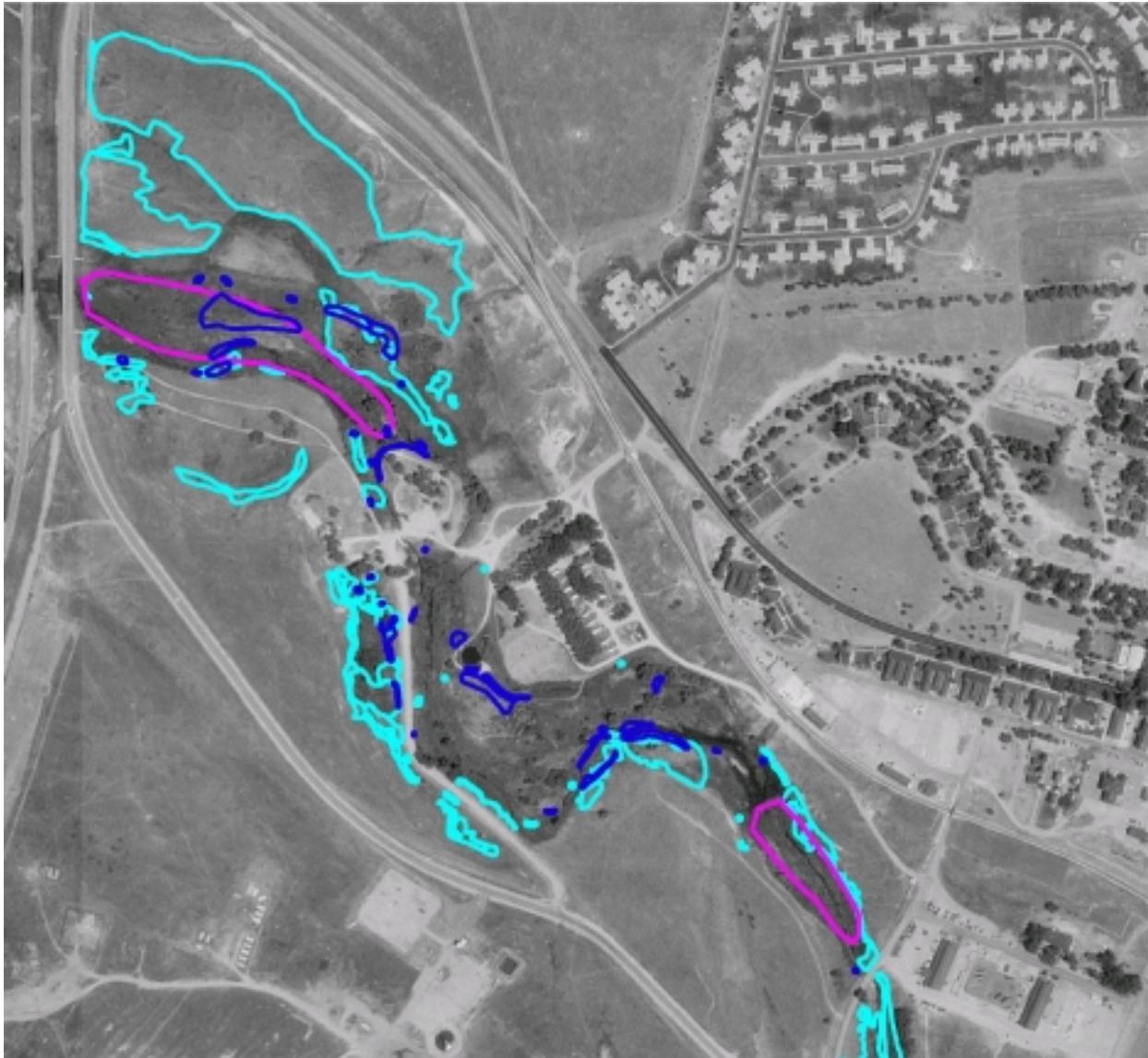
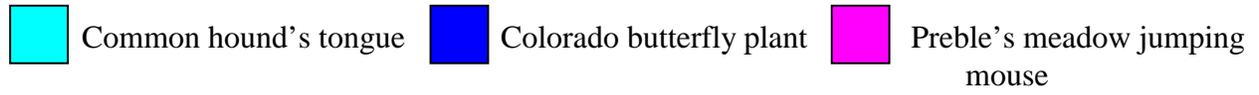


Figure 8. Distribution of Common hound's tongue and Rare Plant and Animal Species Along Middle Crow Creek

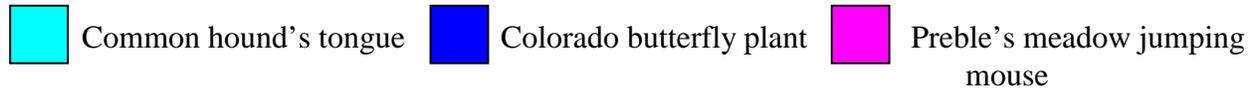


Figure 9. Distribution of Common hound's tongue and Rare Plant and Animal Species Along Diamond Creek

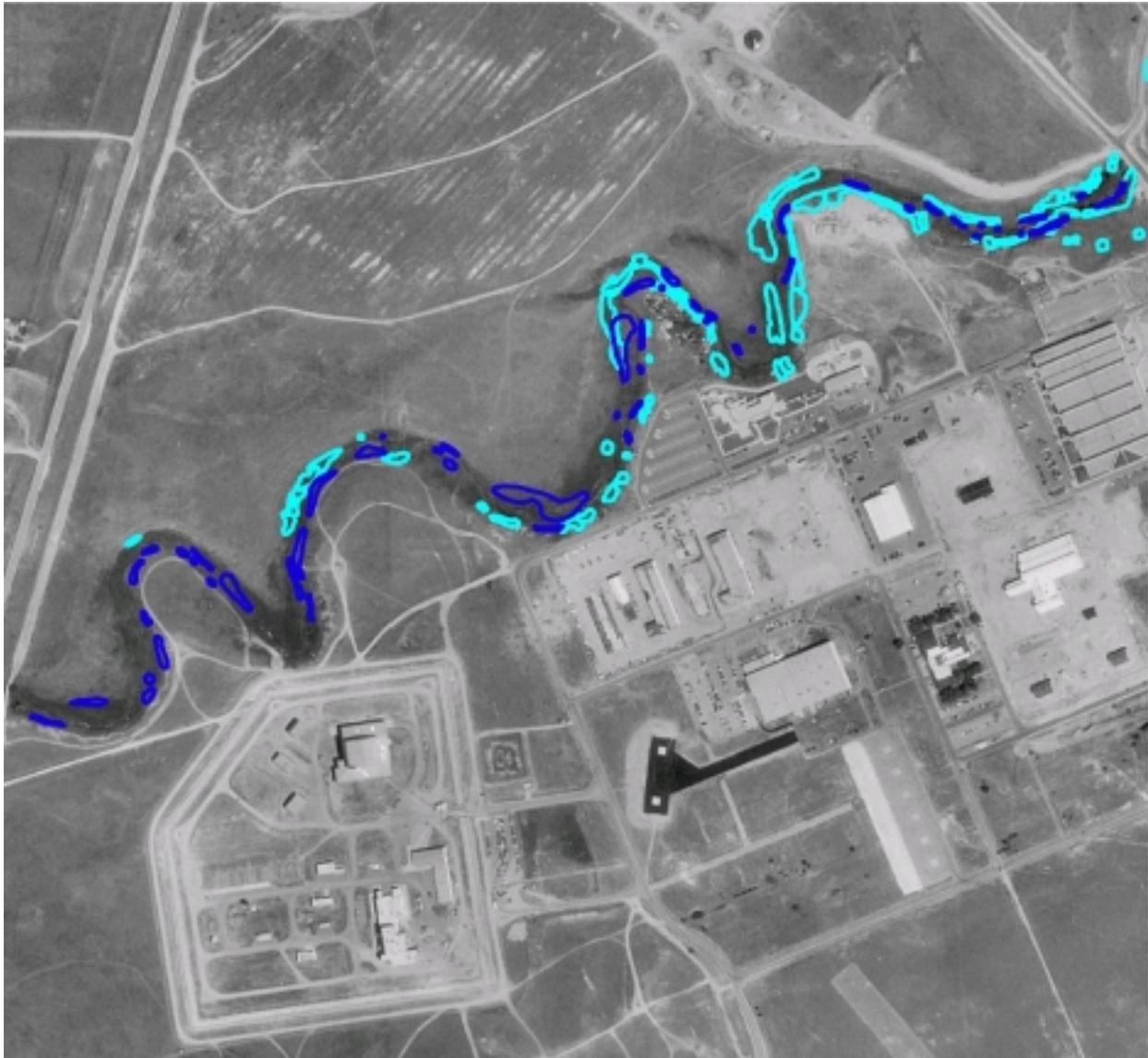
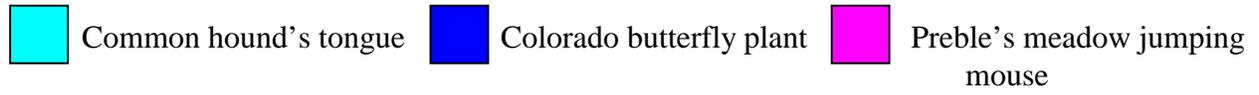


Figure 10. Distribution of Common hound's tongue and Rare Plant and Animal Species Along the Unnamed Drainage

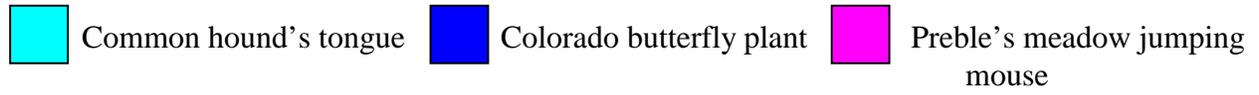


Figure 11. Distribution of Leafy spurge and Rare Plant and Animal Species Along Upper Crow Creek

 Leafy spurge  Colorado butterfly plant  Preble's meadow jumping mouse

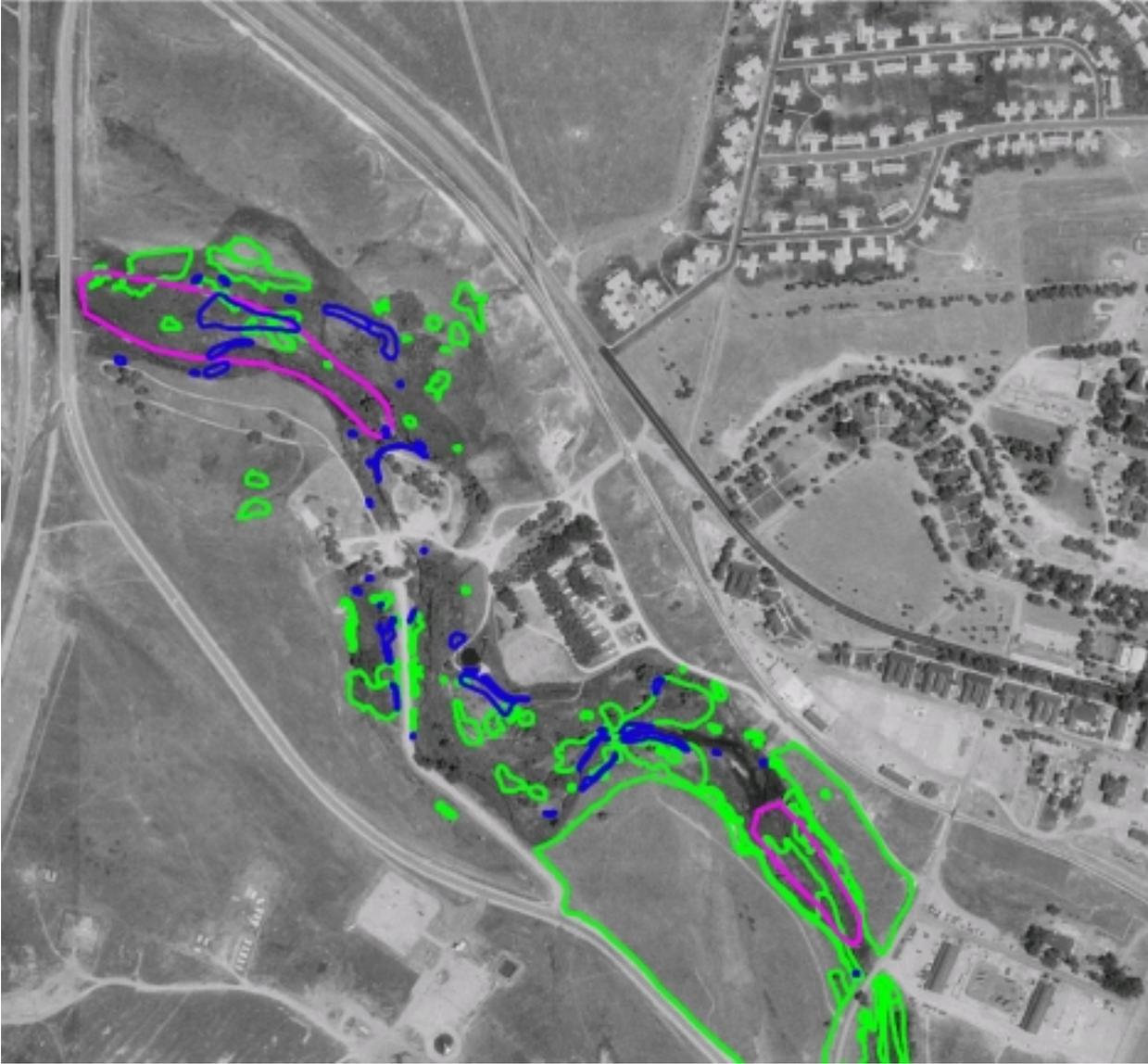


Figure 12. Distribution of Leafy spurge and Rare Plant and Animal Species Along Middle Crow Creek

 Leafy spurge  Colorado butterfly plant  Preble's meadow jumping mouse



Figure 13. Distribution of Leafy spurge and Rare Plant and Animal Species Along Diamond Creek

 Leafy spurge  Colorado butterfly plant  Preble's meadow jumping mouse

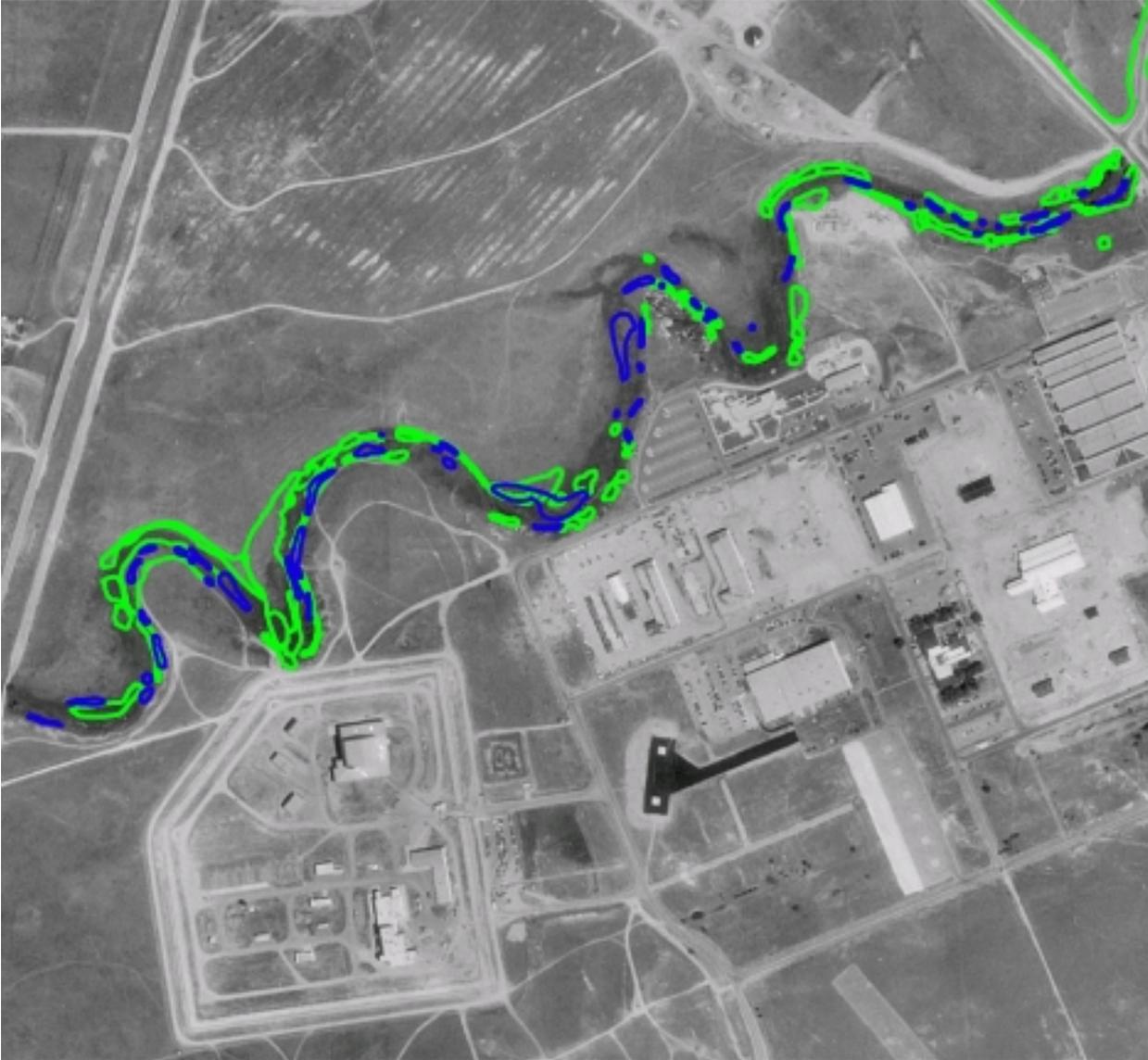


Figure 14. Distribution of Leafy spurge and Rare Plant and Animal Species Along the Unnamed Drainage

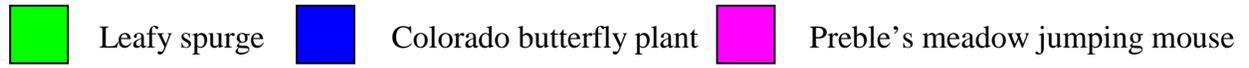


Figure 15. Distribution of Dalmatian toadflax and Rare Plant and Animal Species Along Upper Crow Creek

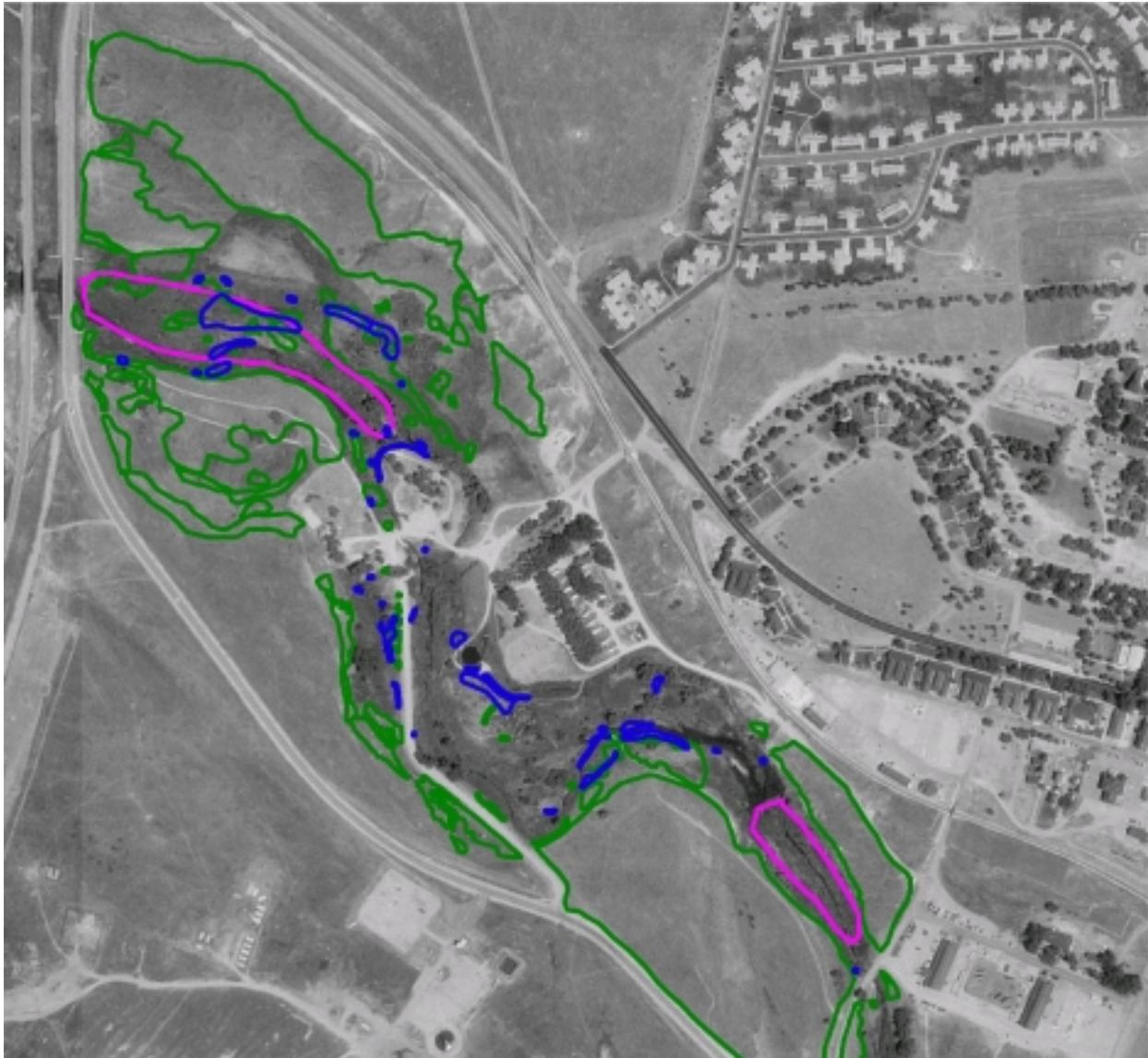
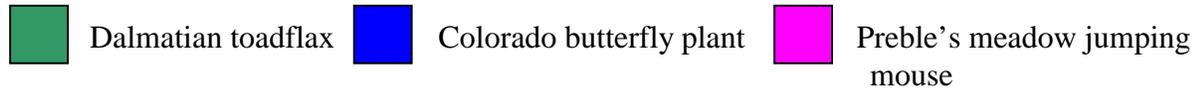


Figure 16. Distribution of Dalmatian toadflax and Rare Plant and Animal Species Along Middle Crow Creek

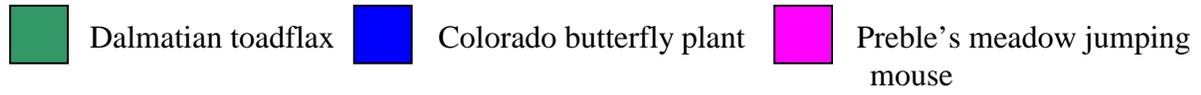


Figure 17. Distribution of Dalmatian toadflax and Rare Plant and Animal Species Along Diamond Creek

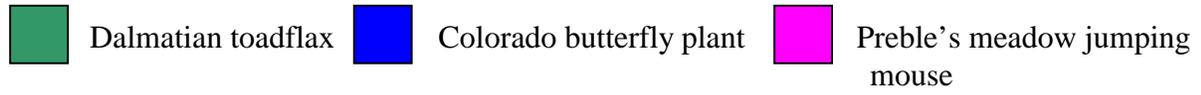


Figure 18. Distribution of Dalmatian toadflax and Rare Plant and Animal Species Along the Unnamed Drainage

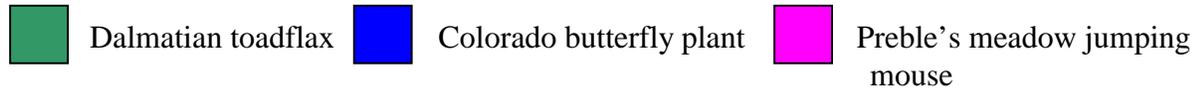
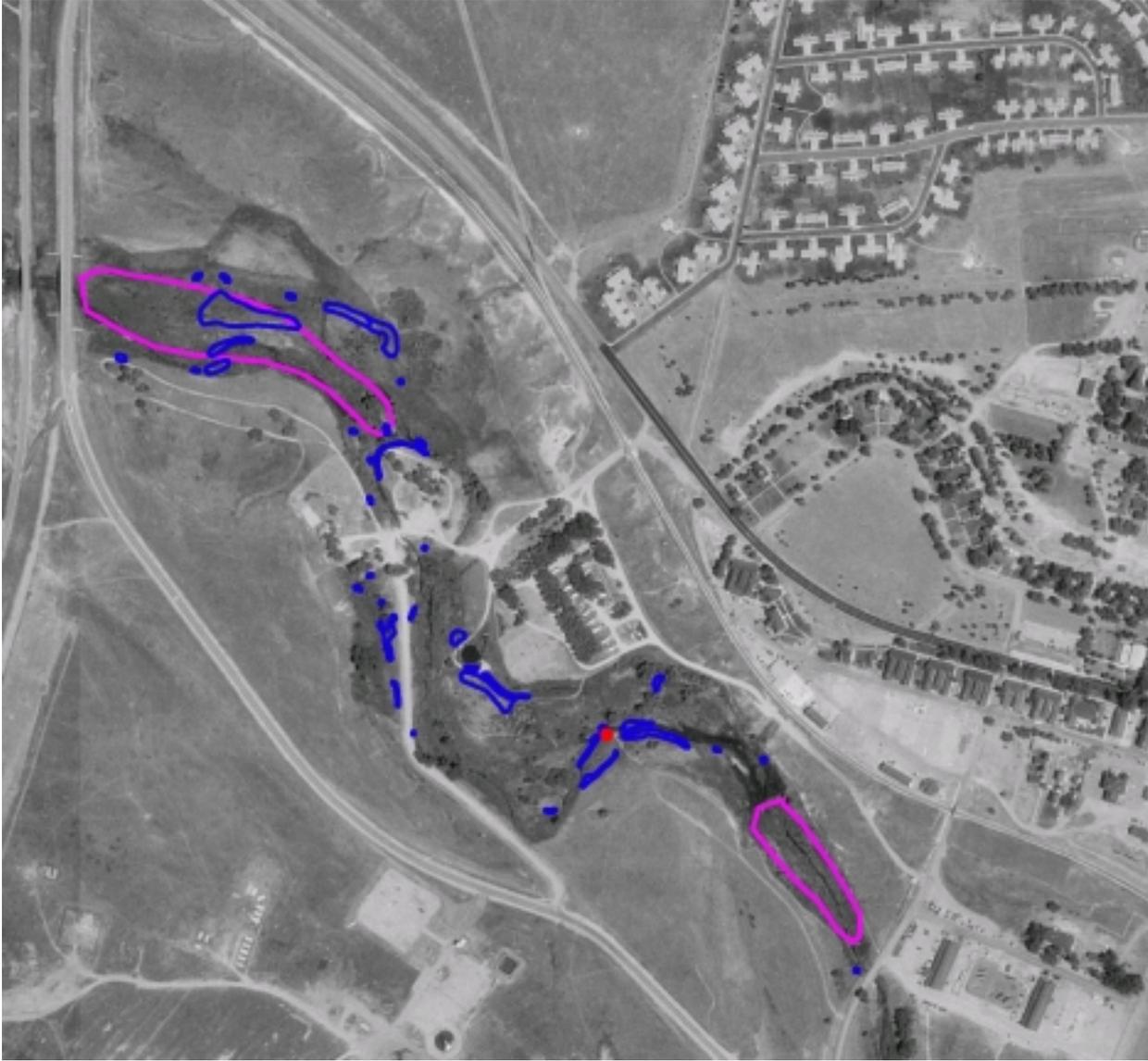
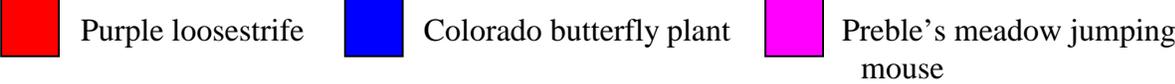


Figure 19. Distribution of Purple loosestrife and Rare Plant and Animal Species Along Upper Crow Creek



Appendix A. Non-Native Plant Species of F.E. Warren Air Force Base

Species list derived from the Easter and Douglas (1996), Hazlett (1999) and collections by Walter Fertig. Exotic species list follows Fertig (1999a). Species with a "\$" are listed as Noxious Weeds under the Wyoming Weed and Pest Control Act. Nomenclature follows Dorn (1992).

Asteraceae

Anthemis cotula (Stinking mayweed)
\$ *Arctium minus* (Common burdock)
Centaurea cyanus (Bachelor's button)
\$ *Cirsium arvense* (Canada thistle)
Lactuca serriola (Prickly lettuce)
Scorzonera laciniata (False salsify)
Taraxacum officinale (Common dandelion)
Tragopogon dubius (Yellow salsify)

Boraginaceae

\$ *Cynoglossum officinale* (Common hound's tongue)

Brassicaceae

Alyssum desertorum (Desert alyssum)
Camelina microcarpa (Littlepod falseflax)
Descurainia sophia (Flixweed)
Sisymbrium altissimum (Tumblemustard)
Thlaspi arvense (Field pennycress)

Caprifoliaceae

Lonicera tatarica (Tatarian honeysuckle)

Caryophyllaceae

Gypsophila paniculata (Baby's breath)

Chenopodiaceae

Chenopodium album (Lambsquarter)
Kochia scoparia (Summer cypress)
Salsola collina (Tumbleweed)

Convolvulaceae

\$ *Convolvulus arvensis* (Field bindweed)

Crassulaceae

Sedum acre (Mossy stonecrop)

Elaeagnaceae

Elaeagnus angustifolia (Russian olive)

Euphorbiaceae

\$ *Euphorbia esula* var. *esula* (Leafy spurge)

\$ *Euphorbia esula* var. *uralensis* (Leafy spurge)

Fabaceae

Astragalus cicer (Chick-pea milkvetch)

Caragana arborescens (Pea-tree)

Coronilla varia (Crown vetch)

Medicago lupulina (Black medic)

Medicago sativa (Alfalfa)

Melilotus albus (White sweetclover)

Melilotus officinalis (Yellow sweetclover)

Trifolium pratense (Red clover)

Juncaceae

Juncus compressus (Compressed rush)

Lamiaceae

Nepeta cataria (Common catnip)

Liliaceae

Asparagus officinalis (Asparagus)

Lythraceae

\$ *Lythrum salicaria* (Purple loosestrife)

Malvaceae

Malva neglecta (Common mallow)

Oleaceae

Syringa vulgaris (Common lilac)

Plantaginaceae

Plantago major (Common plantain)

Poaceae

Agropyron cristatum (Crested wheatgrass)

Agrostis stolonifera (Redtop)

Alopecurus arundinaceus (Creeping foxtail)

Bromus commutatus (Hairy brome)

Bromus inermis var. *inermis* (Smooth brome)

Bromus japonicus (Japanese brome)

Bromus tectorum (Cheatgrass)

Elymus elongatus var. *ponticus* (Tall wheatgrass)
Elymus hispidus (Intermediate wheatgrass)
Elymus repens (Quackgrass)
Eragrostis barrelieri (Mediterranean lovegrass)
Festuca arundinacea (Tall fescue)
Lolium perenne (Perennial ryegrass)
Phleum pratense (Timothy)
Poa compressa (Canada bluegrass)
Poa palustris (Fowl bluegrass)
Poa pratensis (Kentucky bluegrass)
Polypogon monspeliensis (Rabbitfoot-grass)

Polygonaceae

Polygonum aviculare (Prostrate knotweed)
Polygonum convolvulus (Knot bindweed)
Rumex crispus (Curly dock)
Rumex stenophyllus (Slenderleaf dock)

Rhamnaceae

Rhamnus cathartica (Common buckthorn)

Rosaceae

Potentilla norvegica (Norwegian cinquefoil)

Salicaceae

Salix fragilis (Crack willow)

Scrophulariaceae

\$ *Linaria dalmatica* (Dalmatian toadflax)
Verbascum thapsus (Common mullein)
Veronica anagallis-aquatica (Water speedwell)

Appendix B.

Noxious Weeds of F.E. Warren Air Force Base

Cirsium arvense (L.) Scop.
Canada thistle
Asteraceae or Compositae (Sunflower family)

Description: Canada thistle is a dioecious perennial herb with erect stems 30-150 cm tall from deep-seated horizontal roots. Stems and leaves are either nearly glabrous or white-woolly, especially on the underside of the leaves. Lower stem leaves are short-petioled and have shallowly or pinnately lobed (occasionally entire), narrowly elliptic to oblanceolate blades with finely spine-tipped margins. Upper stem leaves are sessile and become progressively smaller. Flower heads are unisexual (either staminate or pistillate) and arranged in a terminal, corymb-like inflorescence. Involucres are 1-2 cm long with 5-6 rows of glabrous to cobwebby sharp-pointed phyllaries. Corollas are typically pink or purple (occasionally white). The pappus consists of feathery bristles and is longer than the corolla in pistillate flowers, but shorter in staminate flowers. Fruits are light brown achenes 2.5-4 mm long (Great Plains Flora Association 1986).

Dorn (1992) recognizes two varieties of *Cirsium arvense* in Wyoming, which differ in the degree of lobing in the leaves. Both varieties intergrade extensively in the state, making distinctions trivial.

Similar Species: Other *Cirsium* species in Wyoming have staminate and pistillate flowers on the same plant and have larger heads (over 1.8 cm long) arranged singly, in sessile clusters, or on axillary stalks. *Carduus acanthoides* has spinnier stems and pappus bristles that lack feathery plumes.

Geographic Range: Despite its common name, Canada thistle is native to Eurasia and northern Africa, but has become widespread across the northern United States and Canada. *C. arvense* occurs throughout Wyoming, but is most abundant on the Eastern Plains and montane valleys of the state.

Habitat: Canada thistle occurs widely along roadsides, disturbed sites, abandoned fields, rangelands, ditchbanks, and moist meadows. On F.E. Warren Air Force base, it is especially abundant along the rims and slopes bordering the channel of Crow and Diamond creeks and along the Unnamed Drainage. This species competes directly with Colorado butterfly plant for habitat along stream meanders. Where Canada thistle has become dense, Colorado butterfly plant populations are reduced or absent.

Population Biology: Canada thistle flowers in late summer and fall, producing copious amounts of seed and feathery pappus. Being dioecious, only the pistillate plants produce seed. This

species is also able to spread vegetatively via deep subterranean rhizomes and can form dense monocultures in a few years. There is some evidence that Canada thistle exhibits allelopathy, but the exact chemical compounds are not known (Wilson 1981). If cut, Canada thistle is able to readily resprout.

Cynoglossum officinale L.
Common hound's tongue
Boraginaceae (Borage family)

Description: Common hound's tongue is a single-stemmed biennial herb with pubescent and leafy stems 30-120 cm tall from a stout taproot. The lowermost leaves are long-petioled with narrowly elliptic blades 2-6 cm wide. (These lower leaves form large rosettes during the first year of the plant's life cycle.) Middle and upper stem leaves are sessile and oblong to lance-shaped. The inflorescence consists of numerous raceme-like branches borne in the axils of upper leaves. Flowers have 5 blunt, green, pubescent sepals and a 5-lobed, dull reddish-purple corolla with anthers borne along the throat. Fruits consist of 4 flattened nutlets covered with short, bristly prickles (Cronquist et al. 1984).

Similar Species: *Lappula* and *Hackelia* species have light blue to white flowers and nutlets bearing spines and prickles on the margins only.

Geographic Range: Native to Europe, but introduced and widespread across North America. This species occurs throughout Wyoming, but is most abundant in the Black Hills and the foothills of the Laramie, Bighorn, and Wyoming ranges.

Habitat: Hound's tongue occurs in disturbed sites, including old fields, meadows, forest margins, and roadsides. On F.E. Warren Air Force Base, it occurs commonly (but sporadically) on terraces, slopes, and meadows bordering the riparian channels of Crow and Diamond Creek.

Population Biology: This species flowers from May-July. Fruits are produced from July to October and readily detach onto pants, shirtsleeves, and other surfaces of large-bodied animals. Hound's tongue does not spread vegetatively. The foliage of this species is toxic to grazing animals, especially horses and cattle.

Euphorbia esula L.
Leafy spurge
Euphorbiaceae (Spurge family)

Synonyms: *Tithymalus esula*, *T. uralensis*.

Description: Leafy spurge is a perennial herb with stout, forked rhizomes and deep roots bearing pink buds (these may sprout to form new stems). All parts of the plant exude a thick, milky latex when broken. Stems are erect, glabrous, 30-70 cm tall, and leafy throughout. Leaves are alternate, narrowly linear to oblong, 3-9 cm long and 3-8 mm wide. The inflorescence is an umbel of 7-15 forked branches that terminate in a pair of opposite, heart to kidney-shaped, yellowish-green floral bracts subtending several yellowish-green cup-like involucre (cyathia). Each cyathium has a rim of 4 yellowish-green petal-like glands and bears several highly-reduced, unisexual flowers. Pistillate flowers occur singly within the cyathium and bear a long-stalked, 3-parted capsule containing 3 smooth, elliptical seeds. Staminate flowers number 15-25 per cyathium (Cronquist et al. 1997; Great Plains Flora Association 1986; Welsh et al. 1993; Whitson et al. 1991).

Dorn (1992) recognizes two varieties of *E. esula* in Wyoming (these are sometimes considered separate species by other authors). Var. *uralensis* is the most widespread taxon in Wyoming and on F.E. Warren Air Force Base. It can be recognized by its narrow, linear, grass-like leaves that taper to a pointed tip. Var. *esula* is less frequently recorded in the state and differs in having broader, obovate leaves with a rounded tip. A population of var. *esula* has become established along Crow Creek upstream of its confluence with Diamond Creek (*Fertig 18165*).

Similar Species: *Euphorbia cyparissias* has leaves that are less than 2 cm long and 3 mm wide.

Geographic Range: Leafy spurge is native to Eurasia, but was introduced accidentally into North America as a seed impurity in the 1820s (Whitson et al. 1991). Since then, it has spread across southern Canada and the northern United States and has become an especially serious agricultural pest in the northern Great Plains. In Wyoming, leafy spurge is most abundant on the Eastern Plains and in the Black Hills, but can be found sporadically elsewhere.

Habitat: Occurs on a variety of soil types on roadsides, agricultural fields, streambanks, open woodlands, and disturbed areas. On F.E. Warren Air Force Base, Leafy spurge is especially abundant along the benches and terraces bordering Crow and Diamond creeks, on moist organic-rich soils and drier, sandy-gravel sites. It is often absent from wet willow thickets, but may occur on their slightly drier margins or in the understory. Much of the habitat occupied by Leafy spurge is actual or potential Colorado butterfly plant habitat.

Population Biology: Leafy spurge flowers from late May to mid-September. Fruiting capsules

“explode” when dried, forcibly ejecting their seeds for distances of up to 5 meters. This plant is also able to persist and spread via deep rhizomes and roots.

Linaria dalmatica (L.) Mill.
Dalmatian toadflax
Scrophulariaceae (Figwort family)

Synonym: *Linaria genistifolia* ssp. *dalmatica*

Description: Dalmatian toadflax is a glabrous, waxy blue-green perennial herb with erect, multi-branched stems 40-70 cm tall from a creeping horizontal rootstalk. The overlapping leaves are ovate to lance-ovate, sessile, clasping, alternate, and 2-4 cm long x 10-16 mm wide. The inflorescence is an elongate raceme of yellow, bi-lobed, short-stalked, irregular flowers borne in the axils of short bracts. The corolla lips and tube are 14-24 mm long and have a sharp-tipped spur 9-17 mm long. The lower lip has a densely pubescent white to orangish “beard”. Fruits are dry capsules 6-7 mm long that split at the tip to release the seeds (Cronquist et al. 1984).

The name *Linaria genistifolia* is sometimes applied to this species. True *L. genistifolia* is a closely related European taxon with smaller flowers (entire corolla, including spur, is less than 23 mm) and narrow, lance-shaped leaves (Gleason and Cronquist 1991). This species has been reported from the northern Great Plains, but has not been documented in Wyoming (Great Plains Flora Association 1986).

Similar Species: *Linaria vulgaris* has linear to elliptic, non-clasping leaves. *L. canadensis* is a native annual with blue flowers.

Geographic Range: Dalmatian toadflax is native to southeastern Europe, but has been widely introduced across southern Canada and the northern United States. In Wyoming, it is currently most abundant in the Southeastern Plains, Laramie Basin, Jackson Hole, and South Fork Shoshone River Valley, but is rapidly spreading into new areas.

Habitat: Occurs along roadsides, dry to moist meadows, and rangelands, where it can be an aggressive spreader. On F.E. Warren Air Force base, Dalmatian toadflax occurs widely along the drier margins of the Crow and Diamond Creek floodplain on steep slopes or gravelly terraces, but is occurring with increasing frequency in more mesic areas.

Population Biology: Dalmatian toadflax flowers from late July to mid September. Once established, it can be extremely difficult to eradicate because of its waxy foliage that does not readily accept foliar herbicides and its deep root system.

Lythrum salicaria L.
Purple loosestrife
Lythraceae (Loosestrife family)

Description: Purple loosestrife is a robust, rhizomatous perennial herb with slightly tomentose, square stems 50-200 cm tall. Leaves are sessile, opposite or whorled, and have pubescent, oblong or lance-shaped blades 3-10 cm long and 5-20 mm wide. The inflorescence is an elongated, terminal spike with 3 or more flowers arranged in a whorl at each leafy node. The flowers have 6 rose-purple petals 7-12 mm long inserted at the top of a 4-6 mm long, multi-nerved, greenish floral tube. Flowers may consist of three morphological types (all in the same inflorescence), differing in the relative length of the style and stigma. Flowers also have 12 anthers, each alternating in length (long and short). Fruits are small capsules contained within the floral tube (Cronquist et al. 1997; Fertig 1999b; Great Plains Flora Association 1986).

Similar Species: *Lythrum alatum*, an uncommon native species in Wyoming, has glabrate herbage, ovate to oblong leaves less than 4 cm long, and flowers with 6 stamens arranged singly or in pairs at each node of the leafy inflorescence. *Epilobium angustifolium* has 4-petaled flowers and rounded stems. *Liatris* spp. have slender leaves, spike-like inflorescences of thistle-like flower heads, and typically occur in drier habitats. *Verbena hastata* has smaller flowers with a 5-lobed, blue corolla and short-petioled upper stem leaves (Dorn 1992; Great Plains Flora Association 1986).

Geographic Range: Purple loosestrife is native to Eurasia, but has been widely introduced in northeastern and central North America and the Pacific coast (Cronquist et al. 1997; Thompson et al. 1987). In Wyoming, it is currently known from the vicinity of Lovell (Park County), Lusk (Niobrara County), and Cheyenne (Laramie County).

Habitat: *Lythrum salicaria* is an emergent, aquatic, or semi-aquatic plant adapted to streambanks, small ponds, ditches, marshes, and other wetlands or areas with permanently wet soils (Hight and Drea 1991). On F.E. Warren Air Force Base, Purple loosestrife has been found along Crow Creek on damp soil at the edge of thickets of Coyote willow (*Salix exigua*) and Bebb willow (*S. bebbiana*) and moist meadows of Redtop (*Agrostis stolonifera*), Baltic rush (*Juncus balticus*) and Canada thistle (*Cirsium arvense*).

Population Biology: Purple loosestrife flowers from early July to mid August and can produce fruits and seeds over most of the summer. The species is able to spread rapidly by rhizomes or broken stem and root pieces, and is a prolific seed producer.

Additional Comments: Fertig (1999b) documented a small colony of Purple loosestrife near the bridge on the Crow Creek nature trail in September 1996. This patch was manually removed in September 1998, and has not been relocated in 1999 or 2000.