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Inventory of Exotic Plant Species Occurring in Aztec Ruins National Monument

Natural Resource Technical Report NPS/SCPN/NRTR—2010/300

ON THE COVER

Common salsify (*Tragopogon dubius*) was one of the most widespread exotic plant species found in the monument during this inventory.
Photograph by: Safiya Jetha

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Natural Resource Technical Report NPS/SCPN/NRTR—2010/300

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Introduction and Background

Exotic plant species are invading over 70,000 ha (172,973 ac) of habitats in the United States per year (Pimentel et al. 2004). Across the US, exotic species are a leading cause of biodiversity loss, ranking second only to habitat destruction (Brooks 2002). Exotic species invasions have been a primary cause of the listing of over 400 species as threatened or endangered under the Endangered Species Act (Pimentel et al. 2004). These invasions have contributed to the fragmentation of native ecosystems, displacement of native plants and animals, and alterations to ecosystem function. National parks are not immune to exotic plant species' negative impacts on natural resources and visitor experience. Exotic plant species modify landscapes, change natural disturbance regimes, such as fire and flooding, reduce native plant and animal habitat, and increase trail maintenance needs (Young et al. 2007). For national parks in the Southern Colorado Plateau Inventory and Monitoring Network (SCPN), the first step to controlling exotic plants is to complete an exotic species inventory. The inventory results may then be combined with other information to prioritize which exotic species should be controlled first based on their invasiveness and/or feasibility of control and to prioritize which park areas should be controlled first based on their conservation status and/or restoration potential.

Project area

Aztec Ruins National Monument was established in 1923 to preserve ancient Pueblo structures and artifacts that date back from the 1000s to the 1200s. It was once the home of the largest Pueblo community in the Animas River Valley in New Mexico. Excavation of ruins in the 1900s revealed thousands of artifacts and provided a look into the lives of the ancient Pueblo people. The park became a World Heritage site in 1987. Aztec Ruins NM promotes the protection, preservation, and stewardship of its cultural and natural resources.

The historical use of park land for agricultural and grazing purposes has greatly contributed to the introduction and establishment of numerous exotic plant species (AZRU 1989). In addition, an existing trailer park subdivision south of the park, a new subdivision being developed north and west of the park, and gas wells are all potential vectors for exotic species introduction and establishment within park boundaries.

Project overview

The objectives of this project were to complete an exotic plant inventory, collect voucher specimens for new exotic species in the park, and write a report on exotic plant species occurring in Aztec Ruins National Monument. I will incorporate data from this inventory into the Vegetation and Cultural Management Environmental Assessment for the park that I am currently co-authoring. The assessment will help to restore and preserve the vegetation and cultural landscape.

Methods

Study area

We conducted the inventory at Aztec Ruins National Monument, which is located entirely within the town of Aztec, New Mexico. The park boundaries encompass approximately 129 ha (320 ac). The park varies in elevation from 1716 m (5629 ft) along the Animas River to 1774 m (5820 ft) on the northern terraces (AZRU 2005). The lower elevation areas of the park lie on Animas River alluvial fill consisting of clay, silt, sand, and gravel derived from the San Juan Mountains in southwest Colorado. At higher elevations, the park is composed of terraces derived from late Pleistocene glacial moraines in the San Juan Mountains. The terraces consist of coarse, rounded gravels and sands that have since been eroded by the Animas River. Soils within most of the park have been impacted by grazing, agricultural activities, residential development, road building, irrigation, archaeological excavation, and visitor activities.

Aztec Ruins National Monument lies within the Upper Sonoran life zone. Almost 300 plant species have been documented in the park, many of which are exotic (Rink and Cully 2008). Common native species in the park include big sagebrush (*Artemisia tridentata*), rabbitbrush (*Chrysothamnus nauseo-*

Figure 1. The farmer's ditch is a major irrigation ditch that runs through Aztec Ruins National Monument. A narrow band of native and exotic plants have established next to the ditch.

sus), Yucca (*Yucca* spp.), Utah juniper (*Juniper osteosperma*), pinyon pine (*Pinus edulis*), and a variety of grasses such as blue grama (*Bouteloua gracilis*), James galleta (*Pleuraphis jamesii*), buffalograss (*Buchloe dactyloides*), alkali sacaton (*Sporobolus airoides*), and Indian ricegrass (*Achnatherum hymenoides*) (AZRU 2004). Riparian vegetation includes cottonwoods (*Populus fremontii*), willows (*Salix exigua*; *S. goodiingii*), box elder (*Acer negundo*), exotic Russian olive (*Elaeagnus angustifolia*), and tamarisk (*Tamarix chinensis*). As the topography rises away from the river, lands historically irrigated for pasture and fruit trees surround the Core Cultural Area that preserves most of the large prehistoric structures. Since acquiring these previously cultivated lands in the late 1990s, the park has discontinued irrigation, following the long range plan to convert the cultivated areas into Upper Sonoran desert scrub native vegetation (AZRU 2005). In 1892, irrigators constructed the Farmer's Ditch, a major irrigation ditch running east-west through the park that supports a narrow band of native and exotic riparian vegetation (fig. 1). On the higher north terrace, native galleta and alkali sacaton grasses dominate. Broom snakeweed (*Gutierrezia sarothrae*) also dominates the mesa slopes, providing evidence of historic degradation due to grazing and fire suppression. Less frequent native species on the mesa slopes include Indian rice grass, prairie three-awn (*Aristida purpurea*), big sagebrush, four winged saltbush (*Atriplex canescens*), and prickly pear cactus (*Opuntia phaeacantha*, *O. polyacantha*).

Sampling design

This inventory is one of several inventories that have been or will be conducted in small national monuments of the Southern Colorado Plateau Network (SCPN). Sampling followed a systematic, grid-based approach (Young et al. 2007) to ensure rapid and repeatable data collection. The SCPN spatial analyst created a gridded map of the park property, resulting in 56 grid cells, each approximately two ha (4.95 ac) in area. Irregular polygons were reshaped to create consistency in grid unit size and search efficiency (fig. 2). Within each grid cell, a diagonal 50-m transect, along which vegetation and environmental data was collected, was mapped through the cell center. We shifted transects that intersected physical park structures or roads to avoid these features. We conducted the inventory from June to July 2008 during the peak-growing season. In late July and August, we did a general resurvey of the area to determine if any new species had emerged since sampling.

Field methods

The field crew consisted of one professional botanist and one student field assistant. To navigate to all grid cells and transect locations, we used a Garmin GPS unit that was pre-programmed with mapping coordinates for all 56 grid cells and 50-m transects. We marked all transect beginning and ending points with the GPS in order to verify the transect locations. The SCPN also provided us with a paper map, which we used to reference known ground features and structures for orientation. We relocated seven transects because their original locations intersected a physical structure or road. In situations where it was necessary to relocate transects, we kept at least one of the original points as a starting point for transect location. We relocated transects from the following grid cells: 13, 14, 19, 20, 45, 47, and 53.

Vegetation

The field crew became familiar with both the exotic and native species occurring within the park prior to conducting the inventory.

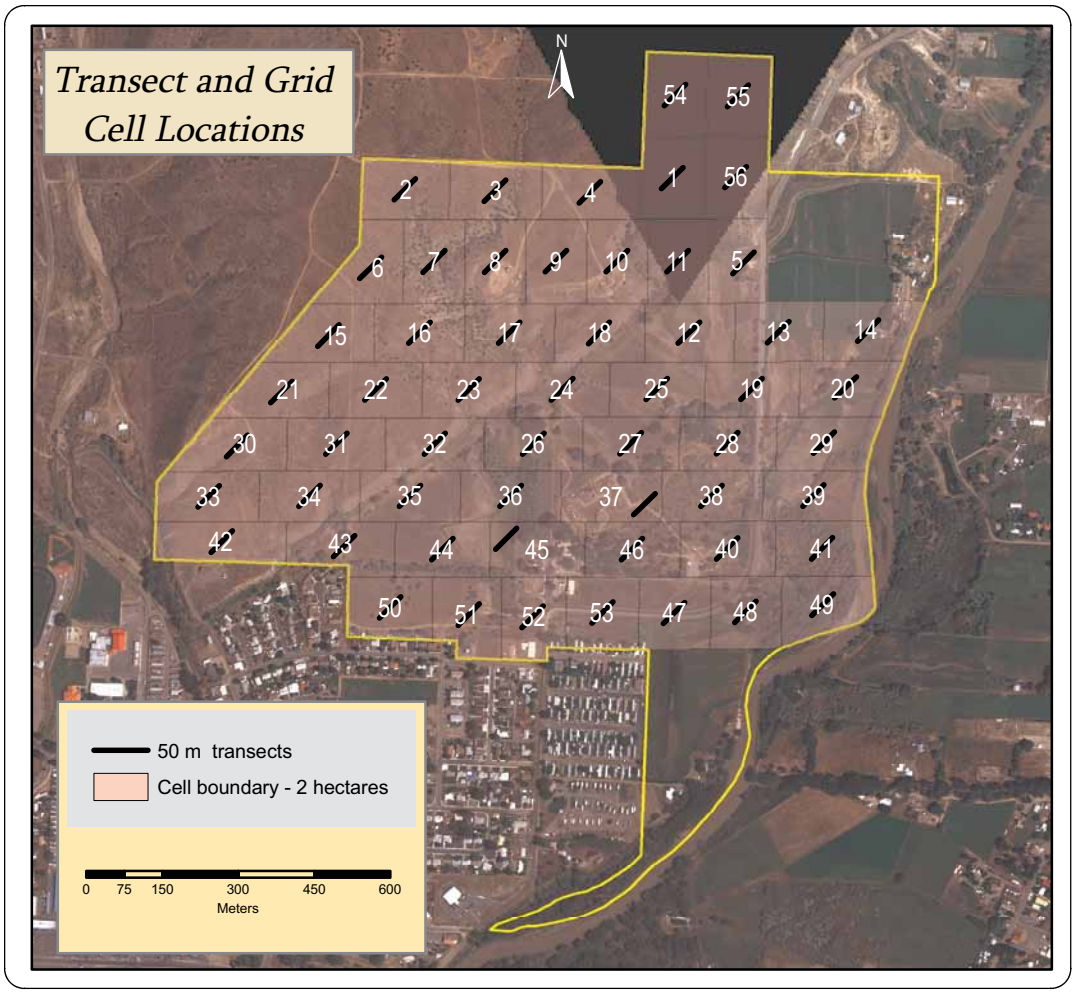

Figure 2. Map of the sampling design for the exotic plant inventory. Each grid cell was approximately 2 ha. One 50-m transect was sampled within each cell.

We used a species list compiled by Glenn Rink and Anne Cully from 2002-2007 as a botanical reference (Rink and Cully 2008). The observer collected any unknown species in a plant press and identified them to the species level. The three species we determined to be exotic that had not been listed by Rink and Cully (2008) were photographed, marked with the GPS system, and collected in a plant press for voucher specimens. We collected and carefully pressed the best specimens, ideally those with fruit, flower, and leaves.

We classified each of the 56 grid cells into one of six land use types: Core Cultural Area, Farmer's Ditch, Old Fields/Cultivated Lands, Orchards, Riparian/Floodplains, and Uplands/Slopes (fig. 3). These are the same six land use types that we will use in the Vegetation and Cultural Management Environmental Assessment for the park. We established a variable width belt along each 50-m transect (fig. 4). We used a 4-m belt width in areas that were in the Uplands/Slopes land use type and a 3-m belt width in the five lowland land use types. The botanist documented the exotic species along the 50-m variable width belt transect and assigned a cover class for each exotic species. We assigned a cover class using the following cover class system: 1=less than 0.1% foliar cover, 2=0.1 to 1%, 3=1 to 5%, 4=5 to 10%, 5=10 to 25%, 6= 25 to 50%, and 7=50 to 100% (Young et al. 2007). We then used the GPS to walk the perimeter and the area inside the entire grid cell to identify any additional exotic species found within the grid cell but not within the 50-m variable width belt transect.

Environmental measures

The student research assistant took soil samples and measured aspect, slope, tree canopy cover, and soil disturbance. The observer took soil samples every 10 m, starting at the 5-m mark along the transects.

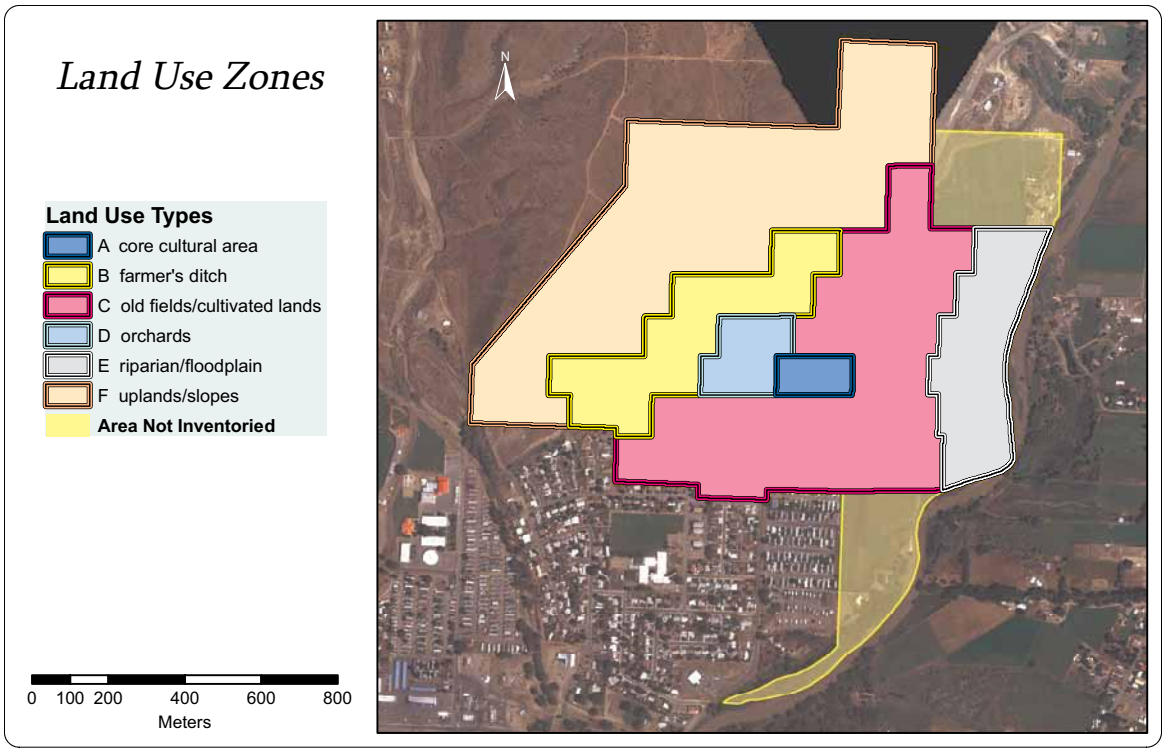

Figure 3. Map of the categories of land use used to compare grid cells in this inventory.

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Figure 4. A belt established around one of the 50-m transcects. The flags mark the border of the belt. The botanist documented the presence of exotic species and then estimated their covers within the belt.

We used a trowel to collect approximately 2.5 cups of soil at each of the five sampling points, which we then stored in a brown paper bag marked with the grid number and collection date. We stored the bags in the refrigerator at the end of each field day. The observer recorded aspect with a compass at the 25-m mark. We measured the slope using a clinometer from the 0-m mark looking towards the 50-m mark. One observer stood at the 0-m mark and the other at the 50-m mark. In areas where the topography was inconsistent, a reading was taken from 0-25 meters and then from 25-50 meters and averaged. We measured tree canopy cover using a densitometer every 10 m, starting at the 5-m mark along transects. We quantified soil disturbance by the amount of organic soil that had been removed in a given area. We used the following soil disturbance scale: 1=bladed road, 2=heavy disturbance where more than 75% of the organic soil had been removed, 3=intermediate disturbance where 40-75% of the organic soil has been removed, 4=light disturbance where less than 45% of organic soil has been removed, and 5=where there was no disturbance (Korb et al. 2007). At the 2-m mark, the observer took four photographs in each grid cell: one photograph from 25-0 meters, one photograph from 25-50 meters, and two photographs that represented the general vegetation and geographical features of the grid cell. We also photographed any human disturbances or unique features within each grid cell.

Laboratory methods

We used standard soil analysis methodology to quantify soil organic matter and soil pH. We determined the percent soil organic matter by heating soil samples to 430° C for two hours in a muffle furnace, and then we subtracted soil weight after combustion from the soil weight before combustion and divided that number by the soil weight before combustion. We determined soil pH using the soil pH slurry method. We weighed 10 g of soil from each grid cell sample, mixed the soil with 10 ml of distilled water in a flask and agitated each sample for 20 minutes. We used a pH meter to record pH readings.

Statistical data summary

The SCPN data manager designed the Microsoft Access database and queries used to summarize the inventory data. We entered the data into the database, verified all data records, and made corrections as needed. We analyzed data using SAS JMP-IN Version 7 and used Microsoft Excel to create tables and figures. The SCPN spatial analyst designed GIS maps displaying the spatial distribution of exotic species within the park.

We calculated the percent exotic cover by first calculating a midpoint for each cover class and then calculating the means from the midpoint data (N=56). We calculated the frequency by adding the number of grid cells for any given individual exotic species and then dividing the frequency by the total number of belt transects in the park (N=56). For example, if a species was present in all 56 belt transects it would have a frequency of 100 percent. If a species was present in 28 belt transects it would have a frequency of 50 percent.

Results

Total plant cover

Total exotic plant cover in Aztec Ruins National Monument was 26.98%. *Kochia scoparia* (common kochia) had the highest overall plant cover for the entire park—an average of 7.43% (table 1). Five other exotic species had an average plant cover greater than one percent for the entire park: *Bromus inermis* (smooth brome) at 4.32%, *Elaeagnus angustifolia* (Russian olive) at 3.48%, *Salsola tragus* (Russian thistle) at 3.47%, *Thinopyrum intermedium* (intermediate wheatgrass) at 2.08% and *Carduus nutans* (musk thistle) at 1.13% (table 1).

Cover by grid cells

Grid cells 35, 39, and 45 had over 100% exotic cover (appendix A). Grid cells 35 and 45 were in the Riparian/Floodplain land use type, and grid cell 39 was in the Farmer's Ditch land use type (fig. 5). Having over 100% exotic cover is possible because the sampling design used cover classes and because all vegetation layers were sampled (i.e.,

Table 1. Average percent cover for individual exotic plant species in Aztec Ruins National Monument.

Species	Common name	Cover (%)
Kochia scoparia	**Common kochia**	**7.43**
Bromus inermis	**Smooth brome**	**4.32**
Elaeagnus angustifolia	**Russian olive**	**3.48**
Salsola tragus	**Russian thistle**	**3.47**
Thinopyrum intermedium	**Intermediate wheatgrass**	**2.08**
Carduus nutans	**Musk thistle**	**1.13**
Bromus tectorum	Cheatgrass	0.93
Alopecurus pratensis	Meadow foxtail	0.80
Cirsium arvense	Canada thistle	0.63
Ulmus pumila	Siberian elm	0.54
Convolvulus arvensis	European bindweed	0.53
Erodium cicutarium	Filaree	0.53
Sisymbrium altissimum	Tumble mustard	0.39
Agrostis capillaris	Colonial bentgrass	0.19
Phleum pratense	Common timothy	0.13
Bromus catharticus	Rescue brome	0.13
Cichorium intybus	Chickory	0.054
Dactylis glomerata	Orchardgrass	0.048
Plantago lanceolata	Lanceleaf plantain	0.046
Cardaria draba	Whitetop	0.045
Asparagus officinalis	Asparagus	0.011
Acroptilon repens	Russian knapweed	0.009
Melilotus officinalis	Yellow sweetclover	0.009
Tragopogon dubius	Common salsify	0.008
Alyssum desertorum	Desert alyssum	0.005
Descurainia sophia	Flaxweed tansymustard	0.004
Hordum marinum ssp. *gussonianum*	Mediterranean barley	0.004
Lactuca serriola	Prickly lettuce	0.003
Rumex crispus	Curly dock	0.003
Taraxacum officinale	Common dandeliion	0.003
Eremopyrum triticeum	Annual wheatgrass	0.002
Aegilops cylindrica	Jointed goatgrass	0.0009
Bromus japonicus	Japanese brome	0.0009
Malva neglecta	Cheeseweed	0.0009
Medicago lupulina	Black medick	0.0009
Medicago sativa	Alfalfa	0.0009
Poa compressa	Canada bluegrass	0.0009
Trifolium pratense	Red clover	0.0009
Verbascum thapsus	Common mullein	0.0009

Note: The six exotic species with over one percent cover over the entire park are in bold.

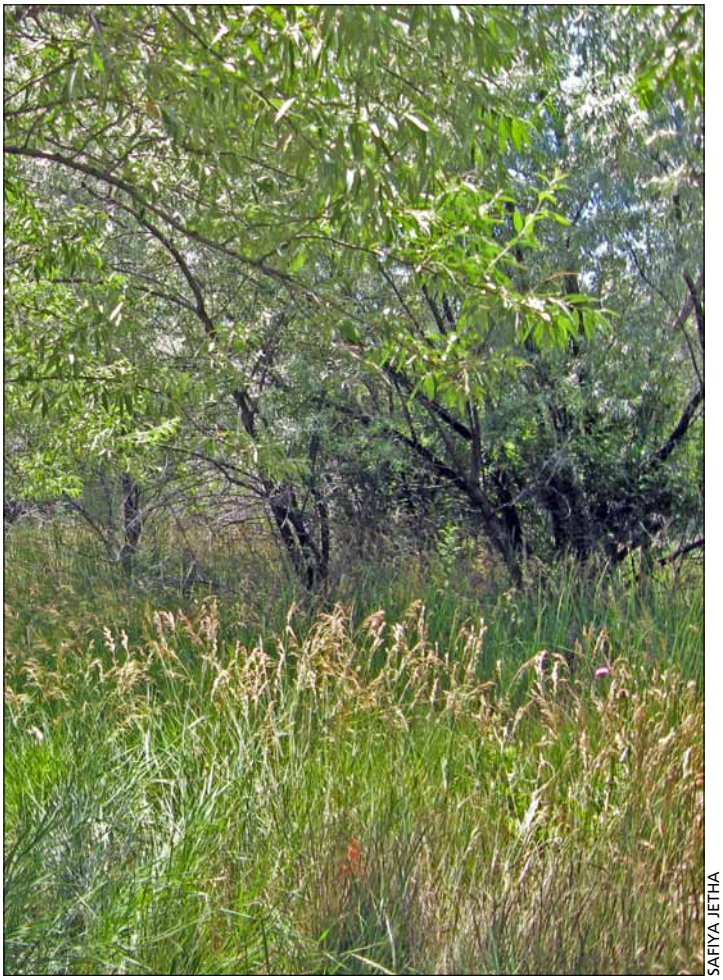

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Figure 5. Grid cell 39 had the highest total exotic plant cover. Most of the cover was composed of *Elaeagnus angustifolia* and *Bromus inermis*.

tree, shrub, herb, ground). Grid cell 39 had the highest total exotic cover—151.5%. This cover consisted of five species: *Elaeagnus angustifolia* (75%), *Bromus inermis* (75%), *Carduus nutans* (0.5%), *Thinopyrum intermedium* (0.5%) and *Convolvulus arvensis* (European bindweed) (0.05%). Eleven additional grid cells had exotic plant cover over 50% (appendix A). Seven of these were in the Old Fields/Cultivated Lands cover type, three were in the Riparian/Floodplain land use type, and one was in the Orchards land use type.

Cover by land use types

The Riparian/Floodplain land use type had the highest average exotic plant cover with 76.7% cover (fig. 6). *Elaeagnus angustifolia* had 31.25% average cover followed by *Bromus inermis* with 18.92%, *Carduus nutans* with 6.76%, *Alopecurus pratensis* with 6.25%, and *Cirsium arvense* with 5% (table 2). The Old Fields/Cultivated Lands land use

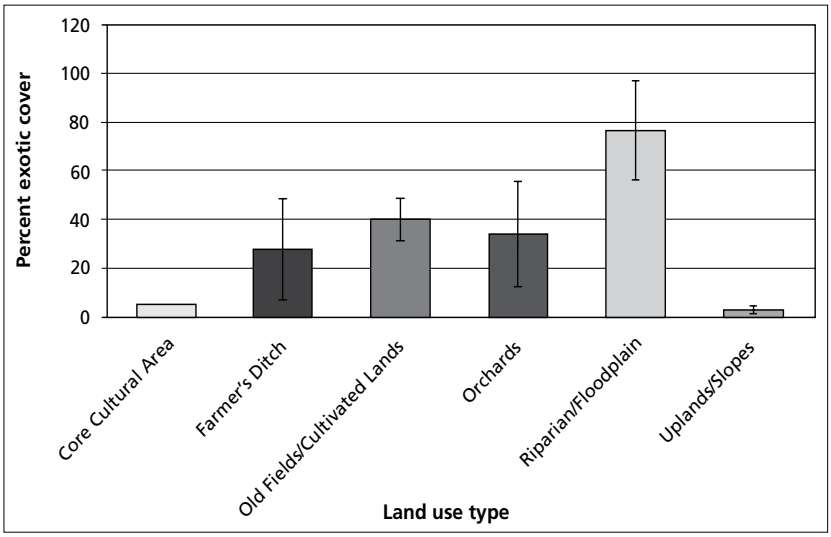


Figure 6. Mean exotic plant cover for each land use type. We identified six land use types in the 56 grid cells: Core Cultural Area (1 grid cell), Farmer's Ditch (7 grid cells), Old Fields/Cultivated Lands (18 grid cells), Orchards (2 grid cells), Riparian/Floodplain (6 grid cells), and Uplands/Slopes (22 grid cells). We calculated the percent exotic cover by first calculating a midpoint for each cover class and then calculating the means from the midpoint data. Error bars represent ±SEM.

Table 2. Average percent cover and frequency for individual exotic plant species in Aztec Ruins National Monument by land use type.

Land use type	Species	Cover (%)	Frequency (%)
Core Cultural Area	*Kochia scoparia*	2.5	100
	Bromus tectorum	2.5	100
	Convolvulus arvensis	0.05	100
	Descurainia sophia	0.05	100
	Erodium cicutarium	0.05	100
	Sisymbrium altissimum	0.05	100
Farmer's Ditch	*Kochia scoparia*	12.86	57.14
	Salsola tragus	11.08	42.86
	Sisymbrium altissimum	1.17	85.71
	Bromus tectorum	1.16	85.71
	Elaeagnus angustifolia	1.08	28.57
	Erodium cicutarium	0.093	57.14
	Convolvulus arvensis	0.079	28.57
	Melilotus officinalis	0.071	14.29
	Rumex crispus	0.007	14.29
	Tragopogon dubius	0.007	14.29
	Verbascum thapsus	0.007	14.29
Old Fields/Cultivated Lands	*Kochia scoparia*	17.84	77.78
	Salsola tragus	6.43	50
	Thinopyrum intermedium	5.28	16.67
	Bromus inermis	4.62	33.33
	Ulmus pumila	1.69	22.22
	Carduus nutans	1.28	16.67
	Convolvulus arvensis	1.04	88.89
	Bromus tectorum	0.89	38.89
	Sisymbrium altissimum	0.29	27.78
	Cirsium arvense	0.28	11.11
	Cardaria draba	0.14	5.56
	Cichorium intybus	0.14	5.56
	Erodium cicutarium	0.03	16.67
	Agrostis capillaris	0.03	11.11
	Acroptilon repens	0.028	5.56
	Descurainia sophia	0.01	22.22
	Tragopogon dubius	0.01	22.22
	Dactylis glomerata	0.008	16.67
	Asparagus officinalis	0.006	11.11
	Eremopyrum triticeum	0.006	11.11
	Taraxacum officinale	0.006	11.11
	Aegilops cylindrica	0.003	5.56
	Alopecurus pratensis	0.003	5.56
	Bromus japonicus	0.003	5.56

Table 2, continued. Average percent cover and frequency for individual exotic plant species in Aztec Ruins National Monument by land use type.

Land use type	Species	Cover (%)	Frequency (%)
	Lactuca serriola	0.003	5.56
	Medicago lupulina	0.003	5.56
	Phleum pratense	0.003	5.56
	Plantago lanceolata	0.003	5.56
	Poa compressa	0.003	5.56
	Rumex crispus	0.003	5.56
	Trifolium pratense	0.003	5.56
Orchards	*Bromus inermis*	22.5	100
	Alopecurus pratensis	3.75	50
	Phleum pratense	3.75	50
	Dactylis glomerata	1.25	50
	Kochia scoparia	1.25	50
	Asparagus officinalis	0.25	50
	Bromus tectorum	0.25	50
	Cichorium intybus	0.25	50
	Convolvulus arvensis	0.25	50
	Salsola tragus	0.25	50
	Thinopyrum intermedium	0.25	50
	Cirsium arvense	0.025	50
	Erodium cicutarium	0.025	50
	Lactuca serriola	0.025	50
	Malva neglecta	0.025	50
	Medicago sativa	0.025	50
	Rumex crispus	0.025	50
Riparian/Floodplain	*Elaeagnus angustifolia*	31.25	50
	Bromus inermis	18.92	66.67
	Carduus nutans	6.76	66.67
	Alopecurus pratensis	6.25	16.67
	Cirsium arvense	5	50
	Thinopyrum intermedium	3.51	66.67
	Convolvulus arvensis	1.68	66.67
	Agrostis capillaris	1.67	33.33
	Bromus catharticus	1.25	16.67
	Plantago lanceolata	0.42	16.67
	Tragopogon dubius	0.017	33.33
	Dactylis glomerata	0.008	16.67
	Taraxacum officinale	0.008	16.67
Uplands/Slopes	*Erodium cicutarium*	1.28	27.27
	Bromus tectorum	1.13	90.91
	Sisymbrium altissimum	0.38	40.91
	Alyssum desertorum	0.014	27.27

Table 2, continued. Average percent cover and frequency for individual exotic plant species in Aztec Ruins National Monument by land use type.

Land use type	Species	Cover (%)	Frequency (%)
	Salsola tragus	0.014	27.27
	Hordeum marinum ssp. *gussonianum*	0.009	18.18
	Tragopogon dubius	0.005	9.09
	Acroptilon repens	0.002	4.55
	Agrostis capillaris	0.002	4.55
	Lactuca serriola	0.002	4.55

type had the second highest average exotic plant cover with 40.1% cover (fig. 6). *Kochia scoparia* had 17.84% average cover, followed by *Salsola tragus* with 6.43%, *Thinopyrum intermedium* with 5.28%, *Bromus inermis* with 4.62% and *Ulmus pumila* (Siberian elm) with 1.69% (fig. 6). The Orchards land use type had the third highest average exotic plant cover with 34.2% cover (fig. 6). *Bromus inermis* had 22.5% average cover, followed by *Alopecurus pratensis* (meadow foxtail) with 3.75%, *Phleum pretense* (timothy grass) with 3.75%, *Dactylis glomerata* (orchardgrass) with 1.25%, and *Kochia scoparia* with 1.25% (table 2). The Farmer's Ditch land use type had the fourth highest average exotic plant cover with 27.6% cover (fig. 6). *Kochia scoparia* had 12.86% average cover followed by *Salsola tragus* with 11.08%, *Sisymbrium altissimum* (tumble mustard) with 1.17%, *Bromus tectorum* (cheatgrass) with 1.16%, and *Elaeagnus angustifolia* with 1.08% (table 2). The Core Cultural Area land use type had the fifth highest average exotic plant cover with 5.2% (fig. 6). *Kochia scoparia* and *Bromus tectorum* both had 2.5% average cover and the four other species each had 0.05% average cover (table 2). The Uplands/Slopes land use type had the lowest average exotic plant cover with 2.8% cover (fig. 6). *Erodium cicutarium* (filaree) had 1.28% average cover and *Bromus tectorum* had 1.13% (table 2). The other eight species in the Uplands/Slopes land use type had less than one percent cover. See figure 7 for a map of percent cover by land use type.

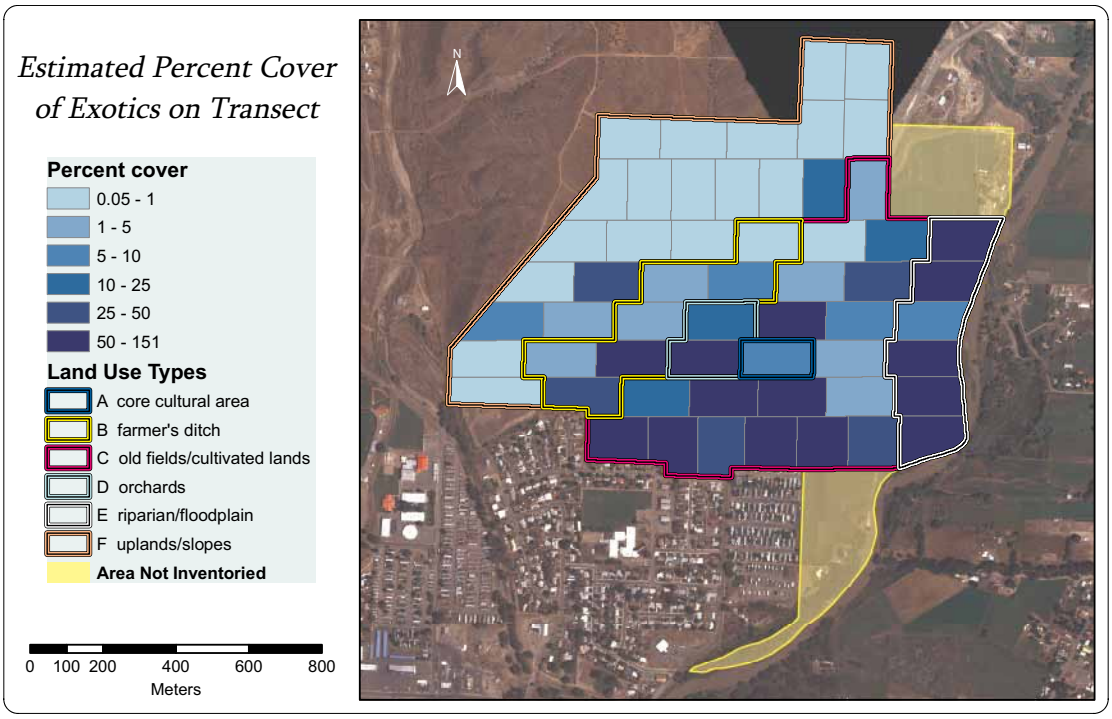


Figure 7. Mean percent cover of exotics over the 50-m transects by grid cell and land use type. Uplands/Slopes belt transects were four meters in width (200 m^2) and all other lowland land use types were three meters in width (150 m^2). We calculated the percent exotic cover by first calculating a midpoint for each cover class and then calculating the mean from the midpoint data. Having over 100% exotic cover is possible because the sampling design used cover classes and because all vegetation layers were sampled (i.e., tree, shrub, herb, ground).

Frequency

We found a total of 39 exotic species within the 56 belt transects, which comprised a total of approximately 1 ha (2.47 ac) sampled area; and 57 exotic species within the 56 grid cells, which comprised a total of approximately 112 ha (277 ac) sampled area (appendix B). The average number of exotic species within the 56 belt transects was 4.4 species and 13.1 species in the grid cells.

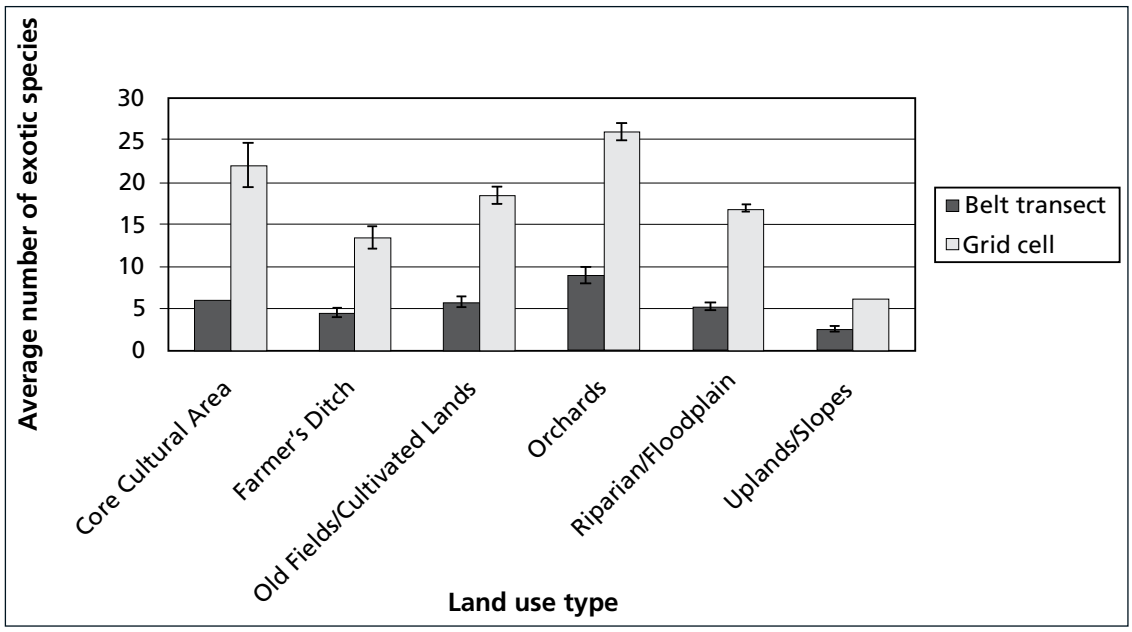
We collected three of the 57 species as voucher specimens because they were new species within the park boundaries. The three species were *Artemisia absinthium*, (absinth wormwood) (fig. 8a), *Hibiscus trionum* (Venice mallow) (fig. 8b), and *Melilotus alba* (white sweet clover) (fig. 8c). *Artemisia absinthium* was found in six grid cells: grid cell 24 (Farmer's Ditch) and grid cells 45, 46, 47, 52, and 53 (Old Fields/Cultivated Lands) (appendix C). *Hibiscus trionum* was found in grid cells 44 and 45, which are both in the Old Fields/Cultivated Lands cover type. *Melilotus alba* was found in grid cells 35 (Farmer's Ditch) and 45 (Old Fields/Cultivated Lands) (appendix C).

The Orchards land use type had the highest average number of exotic species for both the belt transects and grid cells (26, 9) followed by the Core Cultural Area (22, 6), Old Fields/Cultivated Lands (18.4, 5.8), Riparian/Floodplain (16.8, 5.2), Farmer's Ditch (13.4, 4.4), and Uplands/Slopes (6.1, 2.5) land use types (fig. 9). We found the highest total number of exotic species in the Old Fields/Cultivated Lands land use type (51), followed by the Farmer's Ditch (34), Orchards (33), Riparian/Floodplain (33), Core Cultural Area (22), and Uplands/Slopes (20) land use types (appendix C). Grid cell 45 had the highest number of exotic species with 33 exotic species, and grid cell 6 had the lowest number with three exotic species. See Figure 10 for a map of the number of exotic species per grid cell.

Eight exotic species had frequency values of 50 or higher using the grid data, which means that these individual species were found in more than half of the 56 grid cells

Figure 8. Three exotic plant species found during this inventory were new to the park: A) *Artemisia absinthium*, B) *Hibiscus trionum*, and C) *Melilotus alba*.

Figure 9. Mean number of exotic species by land use type in the 50-m belt transects and in the grid cells. We calculated the mean number of exotic species by dividing the total number of a species within a land use type in a grid cell or transect by the number of grid cells or transects for each land use type. Error is presented as ±SEM.



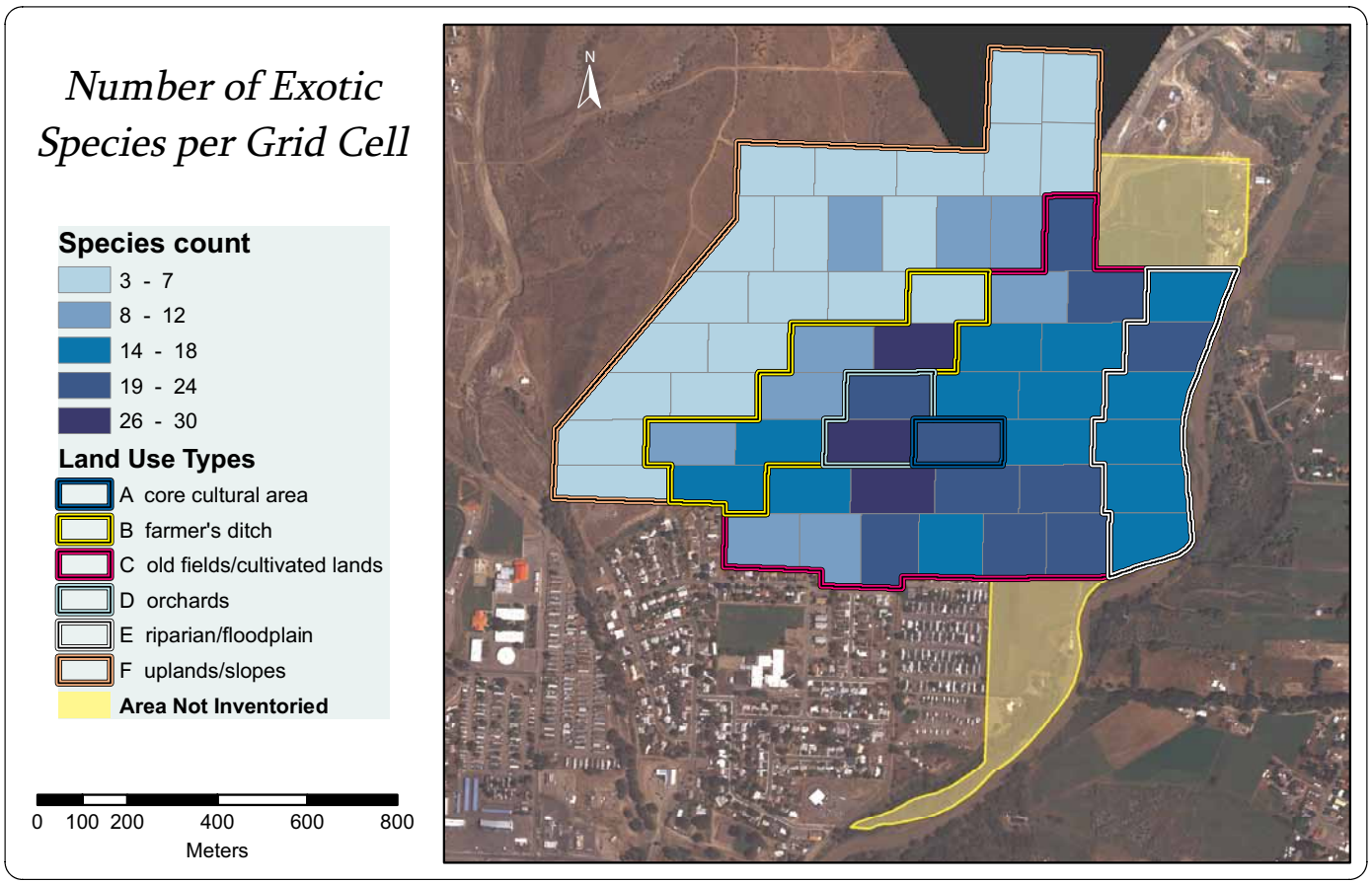


Figure 10. Number of exotic species in grid cells. Each grid cell was approximately two ha each. We identified six land use types: Core Cultural Area (1 grid cell), Farmer's Ditch (7 grid cells), Old Fields/Cultivated Lands (18 grid cells), Orchards (2 grid cells), Riparian/Floodplain (6 grid cells), and Uplands/Slopes (22 grid cells).

in the entire park (table 3). *Bromus tectorum* had the highest frequency, 94.64, followed by *Sisymbrium altissimum* (fig. 11) with 83.93, *Salsola tragus* with 82.14, *Erodium cicutarium* with 71.43, *Tragopogon dubius* (common salsify) with 62.50, *Kochia scoparia* with 57.14, and *Convolvulus arvensis* and *Bromus inermis* with 53.57 (table 3). These six species also had the highest frequency values using the belt transect data; however the frequency values were lower and the order of highest frequency values was not exactly the same (table 3).

Environmental measurements

We calculated environmental variables along the 56 belt transects. The average aspect was 245°, or a southwest/westerly aspect. The average slope was 4.57%. The average soil organic matter was 8.83%, average soil pH was 7.11, and the average soil disturbance was intermediate, where 40-75% of the organic soil had been removed. All envi-

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Figure 11. *Sisymbrium altissimum* had the second highest average frequency among all the exotic plant species. It was present in 83.93% of grid cells.

Table 3. Frequency values for individual exotic plant species in Aztec Ruins National Monument.

Species	Common name	Grid cell frequency (%)	Transect frequency (%)
Bromus tectorum	Cheatgrass	94.64	62.50
Sisymbrium altissimum	Tumble mustard	83.93	37.50
Salsola tragus	Russian thistle	82.14	33.93
Erodium cicutarium	Filaree	71.43	26.79
Tragopogon dubius	Common salsify	62.50	16.07
Kochia scoparia	Common kochia	57.14	35.71
Convolvulus arvensis	European bindweed	53.57	42.86
Bromus inermis	Smooth brome	53.57	21.43
Elaeagnus angustifolia	Russian olive	48.21	8.93
Lactuca serriola	Prickly lettuce	42.86	5.36
Ulmus pumila	Siberian elm	41.07	7.14
Thinopyrum intermedium	Intermediate wheatgrass	41.07	14.30
Carduus nutans	Musk thistle	41.07	12.50
Alyssum desertorum	Desert alyssum	33.93	10.71
Descurainia sophia	Flaxweed tansymustard	32.14	8.93
Medicago sativa	Alfalfa	28.57	1.79
Plantago lanceolata	Lanceleaf plantain	26.79	3.57
Cirsium arvense	Canada thistle	26.79	10.71
Acroptilon repens	Russian knapweed	26.79	3.57
Hordeum marinum ssp. *gussonianum*	Mediterranean barley	25.00	7.14

Table 3, continued. Frequency values for individual exotic plant species in Aztec Ruins National Monument.

Species	Common name	Grid cell frequency (%)	Transect frequency (%)
Taraxacum officinale	Dandelion	21.43	5.36
Melilotus officinalis	Yellow sweetclover	21.43	1.79
Asparagus officinalis	Asparagus	21.43	5.36
Agrostis capillaris	Colonial bentgrass	19.64	8.93
Malva neglecta	Cheeseweed	17.86	1.79
Dactylis glomerata	Orchardgrass	17.86	8.93
Cichorium intybus	Chicory	17.86	3.57
Rumex crispus	Curly dock	16.07	5.36
Verbascum thapsus	Common mullein	14.29	1.79
Eremopyrum triticeum	Annual wheatgrass	12.50	3.57
Arctium minus	Burdock	12.50	-
Tamarix chinensis	Saltcedar	10.71	-
Onopordum acanthium	Scotch thistle	10.71	-
Artemisia absinthium	Absinth wormwood	10.71	-
Alopecurus pratensis	Meadow foxtail	10.71	5.36
Medicago lupulina	Black medick	8.93	1.79
Agropyron cristatum	Crested wheatgrass	8.93	-
Marrubium vulgare	Horehound	7.14	-
Cardaria draba	Whitetop	7.14	1.79
Bromus catharticus	Rescue brome	7.14	1.79
Poa pratensis	Kentucky bluegrass	5.36	-
Poa compressa	Canada bluegrass	5.36	1.79
Phleum pratense	Common timothy	5.36	3.57
Morus alba	White mulberry	5.36	-
Bromus japonicus	Japanese brome	5.36	1.79
Aegilops cylindrica	Jointed goatgrass	5.36	1.79
Trifolium pratense	Red clover	3.57	1.79
Tribulus terrestris	Goathead	3.57	-
Melilotus alba	White sweetclover	3.57	-
Lepidium latifolium	Broadleaf pepperweed	3.57	-
Hibiscus trionum	Flower of an hour	3.57	-
Cardaria chalapensis	Whitetop	3.57	-
Thinopyrum ponticum	Tall wheatgrass	1.79	-
Polypogon monspeliensis	Rabbitsfoot grass	1.79	-
Polygonum aviculare	Prostrate knotweed	1.79	-
Lolium perenne	Perennial ryegrass	1.79	-
Ceratocephala testiculata	Bur buttercup	1.79	-

Note: The "–" symbol represents that the individual exotic species was not found in any of the 50-m belt transects in the park.

ronmental variables varied by land use type (table 4). Aspect varied from the Orchards land use type, which had an average aspect of 210° or south/southwesterly aspect, to the Core Cultural Area land use type, which had an average aspect of 300° or west/northwesterly aspect. Slope varied from the Orchards land use type, which had the lowest average slope of 0.5%, to the Uplands/Slopes land use type, which had the highest average slope of 7.32%. Soil organic matter varied from the Orchards, which had the highest average soil organic matter of 23.61%, to the Uplands/Slopes land use type, which had the lowest average soil organic matter of 3%. Soil pH varied from the Riparian/Floodplains land use type, which had the most acidic soil on average, 6.38 pH, to the Uplands/Slopes land use type, which had the most alkaline soil on average, 7.8 pH. Soil disturbance was highest in the Orchards land use type with average soil disturbance categorized as high disturbance where 75% of the organic soil had been removed. Soils disturbance was lowest in the Uplands/Slopes land use type with average disturbance categorized as light disturbance where less than 45% of the organic soil had been removed.

Discussion

Class A species

The New Mexico Department of Agriculture has listed 20 species as noxious weeds for control and eradication in accordance with the Noxious Weed Management Act of 1998 (New Mexico Department of Agriculture 1998). Government officials have divided New Mexico's noxious weed list into three categories of nonnative species to New Mexico. Class A species have the highest priority because they currently are not found in or are limited in distribution in New Mexico. We found four Class A noxious species in the park: *Cardaria draba* (hoary cress), *Cirsium arvense* (Canada thistle), *Lepidium latifolium* (perennial pepperweed), and *Onopordum acanthium* (scotch thistle).

We found *Cardaria draba* (fig. 12) in one belt transect (grid cell 28) with 2.5% cover in the Old Fields/Cultivated Lands cover type. We also found *Cardaria draba* in grid cells 19 (Old Fields/Cultivated Lands), 26 (Orchards), and 39 (Core Cultural Area) (appendix C). *Cardaria draba* is a perennial forb that spreads primarily from deep vertical and lateral underground roots with numerous aerial shoots (Mulligan and Frankton 1962). *Cardaria draba* is known to establish best in recently disturbed areas such as roadsides, ditch banks, field margins, and gopher mounds (Scurfield 1962). *Cardaria draba* has phytotoxic compounds that can prevent germination and seedling growth of other plants (Kiemnec and McInnis 2002). *Cardaria draba* can not be eliminated by simply removing aboveground plant parts because the roots can remain alive for up to a year and resprout (McInnis et al. 2003). A variety of control techniques is necessary to eradicate *Cardaria draba*, including hand pulling, hoeing, herbicides, and fire.

Table 4. Environmental variable averages for Aztec Ruins National Monument by land use type.

Land use type	Aspect (°)	Slope (%)	Soil organic matter (%)	Soil pH	Soil disturbance
Core Cultural Area	300	5.00	3.87	6.45	2.90
Farmer's Ditch	217	6.00	4.57	7.36	3.36
Old Fields/Cultivated Lands	233	1.83	13.52	6.53	2.43
Orchards	210	0.50	23.61	6.39	2.00
Riparian/Floodplains	238	2.33	17.00	6.38	2.83
Uplands/Slopes	266	7.32	3.00	7.80	3.93

Note: We used the following soil disturbance scale: 1=bladed road, 2=heavy disturbance where more than 75% of the organic soil had been removed, 3=intermediate disturbance where 40-75% of the organic soil has been removed, 4=light disturbance where less than 45% of organic soil has been removed, and 5=there is no disturbance (Korb et al. 2007)

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Figure 12. An infestation of *Cardaria draba. Cardaria draba* is a Class A species—a species currently not found in or with limited distribution in New Mexico.

We found *Cirsium arvense* in six belt transects (grid cells 13, 14, 29, 36, 46, and 49), which were in the Old Fields/Cultivated Lands, Riparian/Floodplain and Orchards land use types (appendix A). We found the highest cover of *Cirsium arvense*, 20%, in grid cell 14 in the Riparian/Floodplain land use type. We also found *Cirsium arvense* in nine additional grid cells (appendix C). *Cirsium arvense* is a perennial forb that has creeping lateral roots that allow it to form dense clonal patches (Whitson et al. 1999). *Cirsium arvense* reproduces over long distances through seed production and locally through horizontal lateral roots. *Cirsium arvense* seeds can germinate within eight to eleven days of flowering, normally reproducing by the following spring because they do not have long seedbank longevity (Moore 1975). *Cirsium arvense* is shade intolerant and establishes readily near roads, streams, ditches, and any areas recently disturbed from fire, grazing, or pocket gophers (Allen and Hansen 1999). *Cirsium arvense* is not easily controlled because it stores nutrients in its roots, allowing it to recover from most types of stress. A combination of repeated treatments is necessary to force a plant to utilize all of its root-stored nutrients, and it takes at least two growing seasons to determine what combination of control methods work for a given area. Hand pulling, tilling, mowing, cutting, burning, herbicide, planting competitive grasses, and biological agents, such as the *Ceutorhyncus litura* (weevil), are all tools to eradicate *Cirsium arvense* (Donald 1994).

We did not find *Lepidium latifolium* or *Onopordum acanthium* on any of the belt transects, but *Lepidium latifolium* was found in grid cells 13 (Old Fields/Cultivated Lands) and 24 (Farmer's Ditch), and *Onopordum acanthium* was found in grid cells 5, 13, 27, 28 (Old Fields/Cultivated Lands) and 42 (Uplands/Slopes) (appendix C). *Lepidium latifolium* is a perennial forb that is most prevalent in riparian and wetland areas but is also found in sagebrush (*Artemisia* spp.) (Pyke 2000). *Lepidium latifolium* has a deep

root system and horizontal creeping roots, which are its primary means of reproduction. Individual plants of *Lepidium latifolium* produce thousands of seeds that also may result in regeneration, although seeds are viable for less than two years (Young et al. 1997). *Lepidium latifolium* requires disturbance for establishment. *Lepidium latifolium* has the ability to alter soil properties to favor its own growth by accumulating excessive salt from leaf litter, thus preventing the growth of salt-intolerant species (Blank and Young 2002). *Lepidium latifolium* can also uptake mercury from soil and emit approximately 70% of the mercury from one growing season into the atmosphere (Leonard et al. 1998). *Lepidium latifolium* is extremely difficult to control by fire, cutting, or disking because it can readily resprout from root fragments that can remain viable for years (Young et al. 1997). Multiple mechanical, chemical, and biological treatment methods are necessary to contain *Lepidium latifolium*. It is crucial to treat small isolated populations because large populations are almost impossible to eradicate.

Onopordum acanthium (fig. 13) is a biennial forb with dense cotton hairs on its leaves. It reproduces from seed only. Individual plants produce between 8,400 and 40,000 seeds (Young and Evans 1969) that can remain viable in the seedbank for up to 16 years (James and Rahman 2003). *Onopordum acanthium* establishes in disturbed areas, primarily near rivers and ditches, but also along roadsides and in agriculture fields. Land managers can control plants by hand removing rosettes after the first growing season before they bolt or by herbicide application before plants bolt (Beck 1991). No biological control methods exist for *Onopordum acanthium*. Seeds can germinate year round, and therefore a combination of mechanical, chemical, and cultural control methods is recommended to eradicate *Onopordum acanthium* (Sheley and Petroff 1999).


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Figure 13. *Onopordum acanthium* establishes in disturbed areas and was found in two of the land use types.

Class B species

We found two species in the park that are Class B exotic species in New Mexico: *Carduus nutans* (musk thistle) and *Acroptilon repens* (Russian knapweed). Class B species are species limited to portions of the state and whose infestations should be contained to prevent further spread. We found *Carduus nutans* in seven belt transects with three of them having 20% cover (appendix A). Two of these belt transects were in the Riparian/Floodplain land use type and one was in the Old Fields/Cultivated Lands cover type. We found *Carduus nutans* in 17 additional grid cells in all six land use types (appendix C). We found *Acroptilon repens* in two belt transects, both with less than 0.5% cover (appendix A). We found one occurrence in the Uplands/Slopes land use type and one in the Old Fields/Cultivated Lands cover type. We found *Acroptilon repens* in 13 additional grid cells in all land use types except the Orchards and Core Cultural Area (appendix C).

Carduus nutans (fig. 14) is a biennial forb that reproduces from seed and has shown the ability to be allelopathic, preventing germination and growth of adjacent species and stimulating recruitment of its own seedlings (Wardle et al. 1993). *Carduus nutans* can grow dense stands in disturbed areas or overgrazed pastures. An individual plant of *Carduus nutans* can produce up to 10,000 seeds, and seeds can remain viable for up to 15 years in the seedbank (Desrochers et al. 1988). Seeds are its only means of reproduction. A combination of mechanical, chemical, and biological control methods can

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Figure 14. *Carduus nutans* is a Class B species—species limited to portions of the state and whose infestations should be contained to prevent further spread.

eradicate *Carduus nutans*. Land managers can most effectively remove *Carduus nutans* mechanically by removing the rosettes before plants bolt and treating the plants with herbicides (McCarty and Hatting 1975). Biological control agents include *Cheilosa corydon* (thistle crown fly), *Puccinia carduorum* (musk thistle rust), and weevils (Rees et al. 1996).

Acroptilon repens is a perennial forb that forms dense colonies from wide, spreading, horizontal roots. *Acroptilon repens* can grow up to 12 m^2 (14 yd^2) radially and 7 m (23 ft) deep within two growing seasons, and the root system can remain viable for up to 75 years (Watson 1980). Reproduction is primarily from horizontal adventitious roots, although an individual *Acroptilon repens* can produce about 1,200 seeds/year (Watson 1980). Although *Acroptilon repens* is commonly found in disturbed areas, it is not as prevalent along roadways and trails as other knapweeds because it primarily spreads vegetatively, which also makes it a poor colonizer. However, once established, it is highly competitive and spreads aggressively (Roche and Roche 1988). *Acroptilon repens* is allelopathic, and its roots and leaves produce chemicals that inhibit other plants from germinating and growing (Stevens 1986). Land managers must use an aggressive, repeated combination of mechanical, chemical, biological, and cultural management techniques to control *Acroptilon repens* populations (Whitson 1999).

Class C species

At Aztec Ruins National Monument, we found all five Class C exotic species listed by the New Mexico Department of Agriculture: *Convolvulus arvensis*, *Tamarix* spp., *Elaeagnus angustifolia*, *Aegilops cylindrical* (jointed goatgrass), and *Ulmus pumila* (Siberian elm). Class C species are widespread in New Mexico and treatment for these species is decided by land managers at the local level based on control feasibility and the degree of infestation.

The highest cover of *Convolvulus arvensis* (fig. 15), with 7.5% cover, was found in grid cell 20 in the Riparian/Floodplains land use type. All other grid cells had less than 2.5% cover, with an average cover of 0.53% for the entire park (appendix A and table 1). *Convolvulus arvensis* was present in approximately 54% of all grid cells within the park and 43% of the belt transects (table 3; appendix C).

Tamarix chinensis was not present in any of the belt transects but was present in approximately 11% of all grid cells within the park (table 3; appendix C). *Elaeagnus angustifolia* was present in approximately 49% of all grid cells within the park and 9% of the belt transects (table 3; appendix C).

Elaeagnus angustifolia had the third highest cover (3.48%) in the park with its highest cover in grid cell 39 (75%) and grid cell 41 (37.5%). Both grid cells were in the Riparian/Floodplains land use type (appendix A). *Tamarix chinensis* and *Elaeagnus angustifolia* are two aggressive exotic trees that may alter stream hydrology and that negatively impact native plant composition and regeneration of (*Populus* spp.) cottonwoods and *Salix* spp. (willows) in arid, southwestern riparian environments (Carman and Brotherson 1982; Howe and Knoff 1991; Sala et al. 1996). *Tamarix chinensis* and *Elaeagnus angustifolia* both need integrated management for successful eradication, including removal of aboveground foliage and stems through cutting or burning and the application of herbicide to stumps, also known as the cut-stump method (Chavez 1996; Caplan 2002).

Aegilops cylindrical was only present in one belt transect, in grid cell 40 in the Old Fields/ Cultivated Lands cover type with a cover of 0.05% (appendix A). *Aegilops cylindrical* was present in approximately 5% of all grid cells within the park (table 3).

Ulmus pumila had the 10th highest cover for the entire park—0.54% (table 1). The highest cover of *Ulmus pumila* was in grid cell 19 with 20% cover (appendix A). *Ulmus pumila* was present in approximately 41% of all grid cells within the park and approximately 7% of the belt transects (table 3; appendix C).

Colorado Class B species

The New Mexico Department of Agriculture also advises land managers to recognize plant species on other federal and western states' noxious weed lists. Three species were listed as Class B species in the state of Colorado: *Artemisia absinthium* (fig. 8a), *Erodium cicutarium*, (redstem filaree), and *Hibiscus trionum* (Colorado Department of Agriculture 2003) (fig. 8b). *Artemisia absinthium* and *Hibiscus trionum* are two new exotic species we identified in the park during this study.

Most abundant species

Kochia scoparia (fig. 16) had the highest plant cover—7.43%—within the entire park and within the Core Cultural Area, Farmer's Ditch, and Old Fields/Cultivated Land use types. *Kochia scoparia* was present in all six land use types but was not located in belt transects in the Orchards, Riparian/Floodplain, or Uplands/Slopes land use types. Research in eastern Colorado along the Arkansas River illustrates that *Kochia scoparia* can form a monocultural stand under riparian vegetation dominated by *Tamarix* spp. (Lindauer 1983), indicating that *Kochia scoparia* has the potential to increase in abundance in riparian areas of the park where its abundance is currently low. *Kochia scoparia* was present in approximately 57% of all grid cells within the park and approximately 36% of all belt transects in the park, indicating a wide spatial distribution for the species. The highest percent cover of *Kochia scoparia* was in grid cells 47 and 53 with approximately 75% cover. *Kochia scoparia* is an annual forb that is commonly used by farmers in dry areas as a drought-resistant forage crop because of its low water requirements and resistance to diseases and insects (Eberlein and Fore 1984). *Kochia scoparia* plants are allelopathic, inhibiting growth of adjacent plants and rapidly colonizing disturbed areas (Lodhi 1979). An individual plant can produce on average 14,600 seeds per year (Eberlein and Fore 1984). Kochia seeds remain viable for less than one year and have a dormancy period of two or three months, germinating in early spring through summer (Iverson and Wali 1982). Kochia seeds are primarily dispersed through stem abscission, hence the common name "tumbleweed", but they also disperse via wind and water. *Kochia scoparia* can be effectively controlled with numerous herbicides (Thomas and Donaghy 1991). Renz (2008) provides specific restoration and management recommendations for eradicating *Kochia scoparia* in New Mexico

K. GEORGE BECK AND JAMES SEBASTIAN

Figure 15. *Convolvulus arvensis* is a Class C species—a species that is widespread in New Mexico.


PHIL WESTRA

Figure 16. *Kochia scoparia* had the highest average cover over the entire park and in the Core Cultural Area, Farmer's Ditch, and Old Fields/Cultivated land use types.

that include a combination of herbicide, grazing, and mechanical treatments. Fire immediately kills *Kochia scoparia* but its effects on removing seeds from the seedbank are unknown.

Most widespread species

Bromus tectorum (fig. 17) had the highest frequency within the park and belt transects. *Bromus tectorum* was present in approximately 95% of all grid cells within the park and approximately 62% of all belt transects, indicating a wide spatial distribution for the species. The highest percent cover of *Bromus tectorum* was in grid cell 11, in the Uplands/Slopes land use type, with 20% cover. The second highest percent cover was in grid cell 19, in the Old Fields/Cultivated Lands cover type, with 7.5% cover (appendix A). *Bromus tectorum* had the seventh highest overall average cover of all species within the park with 0.97% cover (table 1) and was found in all six land use types in the park. It was most prevalent in the Uplands/Slopes land use type (appendix A).

Bromus tectorum is an annual winter graminoid that has rapid growth in spring due to its ability to germinate at low temperatures, which allows it to gain an edge over native vegetation in cold, semi-arid environments (Harris 1967). An individual plant of *Bromus tectorum* can produce up to 5,000 seeds under optimal conditions (Young et al. 1987). *Bromus tectorum* seeds germinate fast and have high success rates under a variety of conditions and can also delay germination for up to two to three years (Goodwin et al. 1996). Disturbance, especially livestock grazing, tree removal, and fire, allows *Bromus tectorum* to flourish when seeds are available either from extant plants or the seedbank. However *Bromus tectorum* can also get established in small openings in relatively undisturbed native vegetation (Hulbert 1955).

Bromus tectorum invasions may result in a self-perpetuating grass-fire cycle. Vegetation, environmental, and fire conditions make this cycle variable, but the end result is generally *Bromus tectorum* outcompeting native vegetation, forming a monoculture that allows the dried plants to burn readily in spring and fall. These burns create microsites for new *Bromus tectorum* plants to get established, which creates a fine fuelbed that increases fire frequency and intensity (Young and Evans 1978). Once *Bromus tectorum* is well-established it is extremely difficult to eradicate and can create its own steady-state; therefore efforts to control *Bromus tectorum* should be taken when abundance is low. Control methods for *Bromus tectorum* must include multiple methods over successive years to be successful, including physical and mechanical removal, herbicide use, grazing, fire with appropriate timing, and seeding and transplants of native perennials (Mosely et al. 1999).

Exotic plant management

The best method to manage exotic species is to prevent their establishment and spread. Their establishment and spread can be prevented by avoiding management actions that encourage invasion, maintaining healthy native plant communities, and monitoring for the presence of exotic species each year (Sheley et al. 1999). In addition, research has shown that manipulations to soil—changing mycorrhizal fungal abundance and soil pathogens and slowing nutrient cycling rates—are necessary to facilitate native plant establishment in previously exotic dominated vegetation, such as agricultural lands (Kulmatiski et al. 2006).

Land managers should continue to moni-


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Figure 17. *Bromus tectorum* was the most widespread species found during this inventory. It was present in 95% of the grid cells.

tor the permanent plots established for this study in order to quantify new exotic species occurrences and changes in abundance and frequency of existing exotic species. The results from this study will allow land managers to target specific exotic species that the New Mexico Department of Agriculture has listed as noxious weeds for control and eradication in accordance with the Noxious Weed Management Act of 1998 (New Mexico Department of Agriculture 1998).

In addition, land managers should target the three new occurrences of exotic plant species within the park (*Artemisia absinthium*, *Hibiscus trionum*, and *Melilotus alba*) before they spread to new areas and become established. All three of these species were found in grid cell 45, which also was the grid cell with the highest number of exotic species in the park. Management should focus control efforts in this grid cell to prevent these species from spreading to adjacent grid cells. Land managers should also identify and control exotic species with high cover (abundance), such as *Kochia scoparia,* and/or high frequency (spatial distribution), such as *Bromus tectorum*.

There is no one optimum method for controlling and eradicating all exotic species; therefore, land managers will be required to utilize an integrated approach of mechanical, biological, cultural, and chemical treatments for the individual species being targeted for removal and for the site-specific vegetation and environmental and cultural conditions where the infestation is occurring. Dispersal of the exotic propagule pool will need to be minimized during exotic weed treatment (Krueger-Mangold et al. 2006). Native species will need to be promoted through a variety of methods including seeding, plugging, transplants, and natural reestablishment from on site native vegetation (Albrecht et al. 2005). A successional management approach that incorporates ecological processes (plant succession) and a long-term perspective to controlling exotic species is paramount for the long-term success of establishing native plant communities (Krueger-Mangold et al. 2006). The establishment of self-sustaining native plant communities is one of the most effective methods to prevent future exotic plant invasions and should be the ultimate goal of any restoration effort to remove exotic species. Numerous studies in a variety of plant communities have shown site-specific examples where seeding, transplanting of native species or in situ native species competition can suppress exotic plant species (Cox and Anderson 2004, Talluto et al. 2006, Endress et al. 2008, Getz and Baker 2008, Reinhardt Adams and Galatowitsch 2008, Rowe and Brown 2008).

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Appendix A. Cover of Exotic Plant Species

Appendix A contains a list of exotic plant species with their percent covers for each grid cell. Each grid cell was approximately two hectares. We identified land use types by dominant species and physical land attributes. The six land cover types were: Core Cultural Area (1 grid cell), Farmer's Ditch (7 grid cells), Old Fields/Cultivated Lands (18 grid cells), Orchards (2 grid cells), Riparian/Floodplain (6 grid cells), and Uplands/Slopes (22 grid cells). We calculated the percent cover for each speices by first calculating a midpoint for each cover class and then calculating the mean from the midpoint data (N=56).

Grid cell	Land use type	Species	Cover (%)
1	Uplands/Slopes	*Bromus tectorum*	0.05
1	Uplands/Slopes	*Sisymbrium altissimum*	0.05
2	Uplands/Slopes	*Sisymbrium altissimum*	0.05
3	Uplands/Slopes	*Bromus tectorum*	0.05
3	Uplands/Slopes	*Hordeum marinum* ssp. *gussonianum*	0.05
4	Uplands/Slopes	*Alyssum desertorum*	0.05
4	Uplands/Slopes	*Bromus tectorum*	0.05
4	Uplands/Slopes	*Hordeum marinum* ssp. *gussonianum*	0.05
4	Uplands/Slopes	*Salsola tragus*	0.05
5	Old Fields/Cultivated Lands	*Kochia scoparia*	2.5
5	Old Fields/Cultivated Lands	*Bromus tectorum*	0.5
5	Old Fields/Cultivated Lands	*Convolvulus arvensis*	0.5
5	Old Fields/Cultivated Lands	*Bromus inermis*	0.05
5	Old Fields/Cultivated Lands	*Eremopyrum triticeum*	0.05
5	Old Fields/Cultivated Lands	*Salsola tragus*	0.05
5	Old Fields/Cultivated Lands	*Sisymbrium altissimum*	0.05
6	Uplands/Slopes	*Bromus tectorum*	0.05
7	Uplands/Slopes	*Bromus tectorum*	0.05
8	Uplands/Slopes	*Alyssum desertorum*	0.05
8	Uplands/Slopes	*Bromus tectorum*	0.05
8	Uplands/Slopes	*Erodium cicutarium*	0.05
8	Uplands/Slopes	*Salsola tragus*	0.05
8	Uplands/Slopes	*Tragopogon dubius*	0.05
9	Uplands/Slopes	*Bromus tectorum*	0.5
9	Uplands/Slopes	*Alyssum desertorum*	0.05
9	Uplands/Slopes	*Erodium cicutarium*	0.05
9	Uplands/Slopes	*Salsola tragus*	0.05
9	Uplands/Slopes	*Sisymbrium altissimum*	0.05
10	Uplands/Slopes	*Acroptilon repens*	0.05
10	Uplands/Slopes	*Bromus tectorum*	0.05
11	Uplands/Slopes	*Bromus tectorum*	20
11	Uplands/Slopes	*Sisymbrium altissimum*	0.05
12	Old Fields/Cultivated Lands	*Convolvulus arvensis*	0.05
12	Old Fields/Cultivated Lands	*Descurainia sophia*	0.05
12	Old Fields/Cultivated Lands	*Sisymbrium altissimum*	0.05
13	Old Fields/Cultivated Lands	*Bromus inermis*	7.5
13	Old Fields/Cultivated Lands	*Carduus nutans*	2.5

Appendix A, continued.

Grid cell	Land use type	Species	Cover (%)
13	Old Fields/Cultivated Lands	*Cirsium arvense*	2.5
13	Old Fields/Cultivated Lands	*Convolvulus arvensis*	0.05
13	Old Fields/Cultivated Lands	*Dactylis glomerata*	0.05
13	Old Fields/Cultivated Lands	*Lactuca serriola*	0.05
13	Old Fields/Cultivated Lands	*Tragopogon dubius*	0.05
14	Riparian/Floodplain	*Alopecurus pratensis*	37.5
14	Riparian/Floodplain	*Cirsium arvense*	20
14	Riparian/Floodplain	*Convolvulus arvensis*	2.5
14	Riparian/Floodplain	*Dactylis glomerata*	0.05
15	Uplands/Slopes	*Hordeum marinum* ssp. *gussonianum*	0.05
16	Uplands/Slopes	*Bromus tectorum*	0.05
16	Uplands/Slopes	*Erodium cicutarium*	0.05
16	Uplands/Slopes	*Sisymbrium altissimum*	0.05
17	Uplands/Slopes	*Agrostis capillaris*	0.05
17	Uplands/Slopes	*Alyssum desertorum*	0.05
17	Uplands/Slopes	*Bromus tectorum*	0.05
17	Uplands/Slopes	*Sisymbrium altissimum*	0.05
18	Farmer's Ditch	*Bromus tectorum*	0.05
18	Farmer's Ditch	*Erodium cicutarium*	0.05
18	Farmer's Ditch	*Rumex crispus*	0.05
18	Farmer's Ditch	*Sisymbrium altissimum*	0.05
19	Old Fields/Cultivated Lands	*Ulmus pumila*	20
19	Old Fields/Cultivated Lands	*Bromus tectorum*	7.5
19	Old Fields/Cultivated Lands	*Convolvulus arvensis*	2.5
19	Old Fields/Cultivated Lands	*Bromus inermis*	0.05
19	Old Fields/Cultivated Lands	*Descurainia sophia*	0.05
19	Old Fields/Cultivated Lands	*Kochia scoparia*	0.05
20	Riparian/Floodplain	*Bromus inermis*	37.5
20	Riparian/Floodplain	*Carduus nutans*	20
20	Riparian/Floodplain	*Convolvulus arvensis*	7.5
20	Riparian/Floodplain	*Thinopyrum intermedium*	0.05
20	Riparian/Floodplain	*Tragopogon dubius*	0.05
21	Uplands/Slopes	*Bromus tectorum*	0.05
22	Uplands/Slopes	*Erodium cicutarium*	20
22	Uplands/Slopes	*Sisymbrium altissimum*	7.5
22	Uplands/Slopes	*Bromus tectorum*	2.5
22	Uplands/Slopes	*Salsola tragus*	0.05
23	Farmer's Ditch	*Bromus tectorum*	2.5
23	Farmer's Ditch	*Erodium cicutarium*	0.05
23	Farmer's Ditch	*Sisymbrium altissimum*	0.05
24	Farmer's Ditch	*Kochia scoparia*	7.5
24	Farmer's Ditch	*Convolvulus arvensis*	0.5
24	Farmer's Ditch	*Melilotus officinalis*	0.5
24	Farmer's Ditch	*Bromus tectorum*	0.05

Appendix A, continued.

Grid cell	Land use type	Species	Cover (%)
24	Farmer's Ditch	*Elaeagnus angustifolia*	0.05
24	Farmer's Ditch	*Tragopogon dubius*	0.05
24	Farmer's Ditch	*Verbascum thapsus*	0.05
25	Old Fields/Cultivated Lands	*Acroptilon repens*	0.5
25	Old Fields/Cultivated Lands	*Convolvulus arvensis*	0.5
25	Old Fields/Cultivated Lands	*Kochia scoparia*	0.5
25	Old Fields/Cultivated Lands	*Descurainia sophia*	0.05
25	Old Fields/Cultivated Lands	*Erodium cicutarium*	0.05
25	Old Fields/Cultivated Lands	*Salsola tragus*	0.05
26	Orchards	*Bromus inermis*	7.5
26	Orchards	*Kochia scoparia*	2.5
26	Orchards	*Bromus tectorum*	0.5
26	Orchards	*Cichorium intybus*	0.5
26	Orchards	*Convolvulus arvensis*	0.5
26	Orchards	*Salsola tragus*	0.5
26	Orchards	*Thinopyrum intermedium*	0.5
26	Orchards	*Erodium cicutarium*	0.05
26	Orchards	*Malva neglecta*	0.05
26	Orchards	*Medicago sativa*	0.05
27	Old Fields/Cultivated Lands	*Kochia scoparia*	37.5
27	Old Fields/Cultivated Lands	*Salsola tragus*	37.5
27	Old Fields/Cultivated Lands	*Convolvulus arvensis*	0.5
28	Old Fields/Cultivated Lands	*Bromus tectorum*	2.5
28	Old Fields/Cultivated Lands	*Cardaria draba*	2.5
28	Old Fields/Cultivated Lands	*Kochia scoparia*	0.5
28	Old Fields/Cultivated Lands	*Bromus inermis*	0.05
28	Old Fields/Cultivated Lands	*Sisymbrium altissimum*	0.05
29	Riparian/Floodplain	*Cirsium arvense*	7.5
29	Riparian/Floodplain	*Carduus nutans*	0.05
29	Riparian/Floodplain	*Convolvulus arvensis*	0.05
29	Riparian/Floodplain	*Taraxacum officinale*	0.05
30	Uplands/Slopes	*Erodium cicutarium*	7.5
30	Uplands/Slopes	*Sisymbrium altissimum*	0.5
30	Uplands/Slopes	*Bromus tectorum*	0.05
30	Uplands/Slopes	*Lactuca serriola*	0.05
31	Uplands/Slopes	*Bromus tectorum*	0.5
31	Uplands/Slopes	*Erodium cicutarium*	0.5
31	Uplands/Slopes	*Alyssum desertorum*	0.05
31	Uplands/Slopes	*Sisymbrium altissimum*	0.05
32	Farmer's Ditch	*Bromus tectorum*	2.5
32	Farmer's Ditch	*Sisymbrium altissimum*	0.5
32	Farmer's Ditch	*Erodium cicutarium*	0.05
33	Uplands/Slopes	*Bromus tectorum*	0.05
34	Farmer's Ditch	*Bromus tectorum*	0.5

Appendix A, continued.

Grid cell	Land use type	Species	Cover (%)
34	Farmer's Ditch	*Erodium cicutarium*	0.5
34	Farmer's Ditch	*Kochia scoparia*	0.05
34	Farmer's Ditch	*Salsola tragus*	0.05
34	Farmer's Ditch	*Sisymbrium altissimum*	0.05
35	Farmer's Ditch	*Kochia scoparia*	75
35	Farmer's Ditch	*Salsola tragus*	75
35	Farmer's Ditch	*Convolvulus arvensis*	0.05
35	Farmer's Ditch	*Sisymbrium altissimum*	0.05
36	Orchards	*Bromus inermis*	37.5
36	Orchards	*Alopecurus pratensis*	7.5
36	Orchards	*Phleum pratense*	7.5
36	Orchards	*Dactylis glomerata*	2.5
36	Orchards	*Asparagus officinalis*	0.5
36	Orchards	*Cirsium arvense*	0.05
36	Orchards	*Lactuca serriola*	0.05
36	Orchards	*Rumex crispus*	0.05
37	Core Cultural Area	*Bromus tectorum*	2.5
37	Core Cultural Area	*Kochia scoparia*	2.5
37	Core Cultural Area	*Convolvulus arvensis*	0.05
37	Core Cultural Area	*Descurainia sophia*	0.05
37	Core Cultural Area	*Erodium cicutarium*	0.05
37	Core Cultural Area	*Sisymbrium altissimum*	0.05
38	Old Fields/Cultivated Lands	*Bromus tectorum*	2.5
38	Old Fields/Cultivated Lands	*Erodium cicutarium*	0.05
38	Old Fields/Cultivated Lands	*Kochia scoparia*	0.05
38	Old Fields/Cultivated Lands	*Salsola tragus*	0.05
39	Riparian/Floodplain	*Bromus inermis*	75
39	Riparian/Floodplain	*Elaeagnus angustifolia*	75
39	Riparian/Floodplain	*Carduus nutans*	0.5
39	Riparian/Floodplain	*Thinopyrum intermedium*	0.5
39	Riparian/Floodplain	*Convolvulus arvensis*	0.05
40	Old Fields/Cultivated Lands	*Kochia scoparia*	2.5
40	Old Fields/Cultivated Lands	*Aegilops cylindrica*	0.05
40	Old Fields/Cultivated Lands	*Asparagus officinalis*	0.05
40	Old Fields/Cultivated Lands	*Bromus japonicus*	0.05
40	Old Fields/Cultivated Lands	*Bromus tectorum*	0.05
40	Old Fields/Cultivated Lands	*Dactylis glomerata*	0.05
40	Old Fields/Cultivated Lands	*Thinopyrum intermedium*	0.05
41	Riparian/Floodplain	*Elaeagnus angustifolia*	37.5
41	Riparian/Floodplain	*Carduus nutans*	20
41	Riparian/Floodplain	*Agrostis capillaris*	2.5
41	Riparian/Floodplain	*Plantago lanceolata*	2.5
41	Riparian/Floodplain	*Bromus inermis*	0.5
41	Riparian/Floodplain	*Thinopyrum intermedium*	0.5

Appendix A, continued.

Grid cell	Land use type	Species	Cover (%)
41	Riparian/Floodplain	*Tragopogon dubius*	0.05
42	Uplands/Slopes	*Bromus tectorum*	0.05
42	Uplands/Slopes	*Salsola tragus*	0.05
43	Farmer's Ditch	*Elaeagnus angustifolia*	7.5
43	Farmer's Ditch	*Kochia scoparia*	7.5
43	Farmer's Ditch	*Sisymbrium altissimum*	7.5
43	Farmer's Ditch	*Bromus tectorum*	2.5
43	Farmer's Ditch	*Salsola tragus*	2.5
44	Old Fields/Cultivated Lands	*Kochia scoparia*	7.5
44	Old Fields/Cultivated Lands	*Sisymbrium altissimum*	2.5
44	Old Fields/Cultivated Lands	*Convolvulus arvensis*	0.5
45	Old Fields/Cultivated Lands	*Thinopyrum intermedium*	75
45	Old Fields/Cultivated Lands	*Carduus nutans*	20
45	Old Fields/Cultivated Lands	*Convolvulus arvensis*	2.5
45	Old Fields/Cultivated Lands	*Agrostis capillaris*	0.05
45	Old Fields/Cultivated Lands	*Alopecurus pratensis*	0.05
45	Old Fields/Cultivated Lands	*Medicago lupulina*	0.05
45	Old Fields/Cultivated Lands	*Phleum pratense*	0.05
45	Old Fields/Cultivated Lands	*Plantago lanceolata*	0.05
45	Old Fields/Cultivated Lands	*Poa compressa*	0.05
45	Old Fields/Cultivated Lands	*Rumex crispus*	0.05
45	Old Fields/Cultivated Lands	*Taraxacum officinale*	0.05
45	Old Fields/Cultivated Lands	*Tragopogon dubius*	0.05
45	Old Fields/Cultivated Lands	*Trifolium pratense*	0.05
46	Old Fields/Cultivated Lands	*Bromus inermis*	75
46	Old Fields/Cultivated Lands	*Ulmus pumila*	7.5
46	Old Fields/Cultivated Lands	*Cirsium arvense*	2.5
46	Old Fields/Cultivated Lands	*Convolvulus arvensis*	0.05
46	Old Fields/Cultivated Lands	*Dactylis glomerata*	0.05
46	Old Fields/Cultivated Lands	*Taraxacum officinale*	0.05
47	Old Fields/Cultivated Lands	*Kochia scoparia*	75
47	Old Fields/Cultivated Lands	*Salsola tragus*	2.5
47	Old Fields/Cultivated Lands	*Convolvulus arvensis*	0.5
48	Old Fields/Cultivated Lands	*Thinopyrum intermedium*	20
48	Old Fields/Cultivated Lands	*Kochia scoparia*	7.5
48	Old Fields/Cultivated Lands	*Bromus tectorum*	2.5
48	Old Fields/Cultivated Lands	*Convolvulus arvensis*	2.5
48	Old Fields/Cultivated Lands	*Agrostis capillaris*	0.5
48	Old Fields/Cultivated Lands	*Convolvulus arvensis*	0.5
48	Old Fields/Cultivated Lands	*Ulmus pumila*	0.5
48	Old Fields/Cultivated Lands	*Descurainia sophia*	0.05
48	Old Fields/Cultivated Lands	*Salsola tragus*	0.05
48	Old Fields/Cultivated Lands	*Tragopogon dubius*	0.05
49	Riparian/Floodplain	*Elaeagnus angustifolia*	75

Appendix A, continued.

Grid cell	Land use type	Species	Cover (%)
49	Riparian/Floodplain	*Thinopyrum intermedium*	20
49	Riparian/Floodplain	*Agrostis capillaris*	7.5
49	Riparian/Floodplain	*Bromus catharticus*	7.5
49	Riparian/Floodplain	*Cirsium arvense*	2.5
49	Riparian/Floodplain	*Bromus inermis*	0.5
50	Old Fields/Cultivated Lands	*Kochia scoparia*	37.5
50	Old Fields/Cultivated Lands	*Salsola tragus*	37.5
50	Old Fields/Cultivated Lands	*Convolvulus arvensis*	2.5
50	Old Fields/Cultivated Lands	*Ulmus pumila*	2.5
51	Old Fields/Cultivated Lands	*Kochia scoparia*	37.5
51	Old Fields/Cultivated Lands	*Salsola tragus*	37.5
51	Old Fields/Cultivated Lands	*Bromus tectorum*	0.5
51	Old Fields/Cultivated Lands	*Convolvulus arvensis*	0.5
51	Old Fields/Cultivated Lands	*Eremopyrum triticeum*	0.05
52	Old Fields/Cultivated Lands	*Kochia scoparia*	37.5
52	Old Fields/Cultivated Lands	*Cichorium intybus*	2.5
52	Old Fields/Cultivated Lands	*Convolvulus arvensis*	2.5
52	Old Fields/Cultivated Lands	*Carduus nutans*	0.5
52	Old Fields/Cultivated Lands	*Erodium cicutarium*	0.5
52	Old Fields/Cultivated Lands	*Tragopogon dubius*	0.05
53	Old Fields/Cultivated Lands	*Kochia scoparia*	75
53	Old Fields/Cultivated Lands	*Convolvulus arvensis*	2.5
53	Old Fields/Cultivated Lands	*Sisymbrium altissimum*	2.5
53	Old Fields/Cultivated Lands	*Bromus inermis*	0.5
53	Old Fields/Cultivated Lands	*Salsola tragus*	0.5
53	Old Fields/Cultivated Lands	*Asparagus officinalis*	0.05
54	Uplands/Slopes	*Bromus tectorum*	0.5
54	Uplands/Slopes	*Hordeum marinum* ssp. *gussonianum*	0.05
54	Uplands/Slopes	*Salsola tragus*	0.05
55	Uplands/Slopes	*Bromus tectorum*	0.05
55	Uplands/Slopes	*Tragopogon dubius*	0.05
56	Uplands/Slopes	*Alyssum desertorum*	0.05
56	Uplands/Slopes	*Bromus tectorum*	0.05

Appendix B. Exotic Plant Species List

Appendix B is the exotic species list for Aztec Ruins National Monument. The list is based on the grid cell data. The grid cells are approximately two hectares each (N=56).

Species	Common name
Acroptilon repens	Russian knapweed
Aegilops cylindrica	jointed goatgrass
Agropyron cristatum	crested wheatgrass
Agrostis capillaris	colonial bentgrass
Alopecurus pratensis	meadow foxtail
Alyssum desertorum	desert alyssum
Arctium minus	burdock
Artemisia absinthium	absinth wormwood
Asparagus officinalis	asparagus
Bromus catharticus	rescue brome
Bromus inermis	smooth brome
Bromus japonicus	Japanese brome
Bromus tectorum	cheat grass
Cardaria chalapensis	whitetop
Cardaria draba	whitetop
Carduus nutans	musk thistle
Ceratocephala testiculata	bur buttercup
Cichorium intybus	chicory
Cirsium arvense	Canadian thistle
Convolvulus arvensis	European bindweed
Dactylis glomerata	orchardgrass
Descurainia sophia	flaxweed tansymustard
Elaeagnus angustifolia	Russian olive
Eremopyrum triticeum	annual wheatgrass
Erodium cicutarium	filaree
Hibiscus trionum	Venice mallow
Hordeum marinum ssp. *gussonianum*	Mediterranean barley
Kochia scoparia	common kochia
Lactuca serriola	prickly lettuce
Lepidium latifolium	broadleaf pepperweed
Lolium perenne	perennial ryegrass
Malva neglecta	cheeseweed
Marrubium vulgare	horehound
Medicago lupulina	black medick
Medicago sativa	alfalfa
Melilotus alba	white sweetclover
Melilotus officinalis	yellow sweetclover
Morus alba	white mulberry
Onopordum acanthium	Scotch thistle
Phleum pratense	common timothy
Plantago lanceolata	lanceleaf plantain

Appendix B, continued.

Species	Common name
Poa compressa	Canada bluegrass
Poa pratensis	Kentucky bluegrass
Polygonum aviculare	prostrate knotweed
Polypogon monspeliensis	rabbitsfootgrass
Rumex crispus	curly dock
Salsola tragus	Russian thistle
Sisymbrium altissimum	tumble mustard
Tamarix chinensis	saltcedar
Taraxacum officinale	dandelion
Thinopyrum intermedium	intermediate wheatgrass
Thinopyrum ponticum	tall wheatgrass
Tragopogon dubius	common salsify
Tribulus terrestris	goathead
Trifolium pratense	red clover
Ulmus pumila	Siberian elm
Verbascum thapsus	common mullein

Appendix C. Exotic Plant Species List By Land Use Type

Appendix C is the exotic species list by each land use type in Aztec Ruins National Monument. The list is based on the grid cell data. The 56 grid cells were approximately two ha each. We identified land use types by dominant species and physical land attributes. The six land use types we used were: Core Cultural Area (1 grid cell), Farmer's Ditch (7 grid cells), Old Fields/Cultivated Lands (18 grid cells), Orchards (2 grid cells), Riparian/Floodplain (6 grid cells), and Uplands/Slopes (22 grid cells).

Land use type	Species	Common name
Core Cultural Area	*Alyssum desertorum*	desert alyssum
	Bromus tectorum	cheat grass
	Cardaria draba	whitetop
	Carduus nutans	musk thistle
	Cichorium intybus	chicory
	Convolvulus arvensis	European bindweed
	Descurainia sophia	flaxweed tansymustard
	Eremopyrum triticeum	annual wheatgrass
	Erodium cicutarium	filaree
	Kochia scoparia	common kochia
	Lactuca serriola	prickly lettuce
	Medicago sativa	alfalfa
	Melilotus officinalis	yellow sweetclover
	Plantago lanceolata	lanceleaf plantain
	Polygonum aviculare	prostrate knotweed
	Salsola tragus	Russian thistle
	Sisymbrium altissimum	tumble mustard
	Taraxacum officinale	dandelion
	Thinopyrum intermedium	intermediate wheatgrass
	Tragopogon dubius	common salsify
	Tribulus terrestris	goathead
	Ulmus pumila	Siberian elm
Farmer's Ditch	*Acroptilon repens*	Russian knapweed
	Agropyron cristatum	crested wheatgrass
	Agrostis capillaris	colonial bentgrass
	Alyssum desertorum	desert alyssum
	Arctium minus	burdock
	Asparagus officinalis	asparagus
	Bromus catharticus	rescue brome
	Bromus inermis	smooth brome
	Bromus tectorum	cheat grass
	Carduus nutans	musk thistle
	Ceratocephala testiculata	bur buttercup
	Convolvulus arvensis	European bindweed
	Dactylis glomerata	orchardgrass
	Descurainia sophia	flaxweed tansymustard
	Elaeagnus angustifolia	Russian olive

Appendix C, continued.

Land use type	Species	Common name
	Erodium cicutarium	filaree
	Hordeum marinum ssp. *gussonianum*	Mediterranean barley
	Kochia scoparia	common kochia
	Lactuca serriola	prickly lettuce
	Lepidium latifolium	broadleaf pepperweed
	Malva neglecta	cheeseweed
	Medicago sativa	alfalfa
	Melilotus officinalis	yellow sweetclover
	Onopordum acanthium	Scotch thistle
	Plantago lanceolata	lanceleaf plantain
	Rumex crispus	curly dock
	Salsola tragus	Russian thistle
	Sisymbrium altissimum	tumble mustard
	Tamarix chinensis	saltcedar
	Taraxacum officinale	dandelion
	Thinopyrum intermedium	intermediate wheatgrass
	Tragopogon dubius	common salsify
	Ulmus pumila	Siberian elm
	Verbascum thapsus	common mullein
Old Fields/Cultivated Lands	*Acroptilon repens*	Russian knapweed
	Aegilops cylindrica	jointed goatgrass
	Agropyron cristatum	crested wheatgrass
	Agrostis capillaris	colonial bentgrass
	Alopecurus pratensis	meadow foxtail
	Alyssum desertorum	desert alyssum
	Arctium minus	burdock
	Asparagus officinalis	asparagus
	Bromus catharticus	rescue brome
	Bromus inermis	smooth brome
	Bromus japonicus	Japanese brome
	Bromus tectorum	cheat grass
	Cardaria chalapensis	whitetop
	Cardaria draba	whitetop
	Carduus nutans	musk thistle
	Cichorium intybus	chicory
	Cirsium arvense	Canadian thistle
	Convolvulus arvensis	European bindweed
	Dactylis glomerata	orchardgrass
	Descurainia sophia	flaxweed tansymustard
	Elaeagnus angustifolia	Russian olive
	Eremopyrum triticeum	annual wheatgrass
	Erodium cicutarium	filaree
	Hordeum marinum ssp. *gussonianum*	Mediterranean barley

Appendix C, continued.

Land use type	Species	Common name
	Kochia scoparia	common kochia
	Lactuca serriola	prickly lettuce
	Lepidium latifolium	broadleaf pepperweed
	Lolium perenne	perennial ryegrass
	Malva neglecta	cheeseweed
	Marrubium vulgare	horehound
	Medicago lupulina	black medick
	Medicago sativa	alfalfa
	Melilotus officinalis	yellow sweetclover
	Morus alba	white mulberry
	Onopordum acanthium	Scotch thistle
	Phleum pratense	common timothy
	Plantago lanceolata	lanceleaf plantain
	Poa compressa	Canada bluegrass
	Poa pratensis	Kentucky bluegrass
	Polypogon monspeliensis	rabbitsfootgrass
	Rumex crispus	curly dock
	Salsola tragus	Russian thistle
	Sisymbrium altissimum	tumble mustard
	Tamarix chinensis	saltcedar
	Taraxacum officinale	dandelion
	Thinopyrum intermedium	intermediate wheatgrass
	Thinopyrum ponticum	tall wheatgrass
	Tragopogon dubius	common salsify
	Tribulus terrestris	goathead
	Trifolium pratense	red clover
	Ulmus pumila	Siberian elm
Orchards	*Agrostis capillaris*	colonial bentgrass
	Alopecurus pratensis	meadow foxtail
	Arctium minus	burdock
	Asparagus officinalis	asparagus
	Bromus inermis	smooth brome
	Bromus japonicus	Japanese brome
	Bromus tectorum	cheat grass
	Cardaria draba	whitetop
	Carduus nutans	musk thistle
	Cichorium intybus	chicory
	Cirsium arvense	Canadian thistle
	Convolvulus arvensis	European bindweed
	Dactylis glomerata	orchardgrass
	Descurainia sophia	flaxweed tansymustard
	Elaeagnus angustifolia	Russian olive
	Erodium cicutarium	filaree

Appendix C, continued.

Land use type	Species	Common name
	Kochia scoparia	common kochia
	Lactuca serriola	prickly lettuce
	Malva neglecta	cheeseweed
	Marrubium vulgare	horehound
	Medicago sativa	alfalfa
	Phleum pratense	common timothy
	Plantago lanceolata	lanceleaf plantain
	Poa compressa	Canada bluegrass
	Poa pratensis	Kentucky bluegrass
	Rumex crispus	curly dock
	Salsola tragus	Russian thistle
	Sisymbrium altissimum	tumble mustard
	Taraxacum officinale	dandelion
	Thinopyrum intermedium	intermediate wheatgrass
	Tragopogon dubius	common salsify
	Ulmus pumila	Siberian elm
	Verbascum thapsus	common mullein
Riparian/Floodplain	*Acroptilon repens*	Russian knapweed
	Agrostis capillaris	colonial bentgrass
	Alopecurus pratensis	meadow foxtail
	Arctium minus	burdock
	Asparagus officinalis	asparagus
	Bromus catharticus	rescue brome
	Bromus inermis	smooth brome
	Bromus japonicus	Japanese brome
	Bromus tectorum	cheat grass
	Cardaria chalapensis	whitetop
	Carduus nutans	musk thistle
	Cirsium arvense	Canadian thistle
	Convolvulus arvensis	European bindweed
	Dactylis glomerata	orchardgrass
	Elaeagnus angustifolia	Russian olive
	Erodium cicutarium	filaree
	Kochia scoparia	common kochia
	Lactuca serriola	prickly lettuce
	Malva neglecta	cheeseweed
	Marrubium vulgare	horehound
	Melilotus officinalis	yellow sweetclover
	Plantago lanceolata	lanceleaf plantain
	Poa compressa	Canada bluegrass
	Poa pratensis	Kentucky bluegrass
	Rumex crispus	curly dock
	Salsola tragus	Russian thistle

Appendix C, continued.

Land use type	Species	Common name
	Sisymbrium altissimum	tumble mustard
	Tamarix chinensis	saltcedar
	Taraxacum officinale	dandelion
	Thinopyrum intermedium	intermediate wheatgrass
	Tragopogon dubius	common salsify
	Ulmus pumila	Siberian elm
	Verbascum thapsus	common mullein
Uplands/Slopes	*Acroptilon repens*	Russian knapweed
	Agrostis capillaris	colonial bentgrass
	Alopecurus pratensis	meadow foxtail
	Alyssum desertorum	desert alyssum
	Bromus inermis	smooth brome
	Bromus tectorum	cheat grass
	Cirsium arvense	Canadian thistle
	Convolvulus arvensis	European bindweed
	Descurainia sophia	flaxweed tansymustard
	Erodium cicutarium	filaree
	Hordeum marinum ssp. *gussonianum*	Mediterranean barley
	Kochia scoparia	common kochia
	Lactuca serriola	prickly lettuce
	Melilotus officinalis	yellow sweetclover
	Onopordum acanthium	Scotch thistle
	Rumex crispus	curly dock
	Salsola tragus	Russian thistle
	Sisymbrium altissimum	tumble mustard
	Tamarix chinensis	saltcedar
	Tragopogon dubius	common salsify

Appendix D. Exotic Plant Species List By Grid Cell

Appendix D is the exotic species list by grid cell in Aztec Ruins National Monument. The 56 grid cells were approximately two ha each. We identified land use types by dominant species and physical land attributes. The six land use types we used were: Core Cultural Area (1 grid cell), Farmer's Ditch (7 grid cells), Old Fields/Cultivated Lands (18 grid cells), Orchards (2 grid cells), Riparian/Floodplain (6 grid cells), and Uplands/Slopes (22 grid cells).

Grid cell	Land use type	Species
1	Uplands/Slopes	*Alyssum desertorum*
		Bromus tectorum
		Hordeum marinum ssp. *gussonianum*
		Salsola tragus
		Sisymbrium altissimum
2	Uplands/Slopes	*Bromus tectorum*
		Hordeum marinum ssp. *gussonianum*
		Sisymbrium altissimum
		Tragopogon dubius
3	Uplands/Slopes	*Bromus tectorum*
		Hordeum marinum ssp. *gussonianum*
		Lactuca serriola
		Sisymbrium altissimum
4	Uplands/Slopes	*Alyssum desertorum*
		Bromus tectorum
		Hordeum marinum ssp. *gussonianum*
		Salsola tragus
5	Old Fields/Cultivated Lands	*Acroptilon repens*
		Aegilops cylindrica
		Agropyron cristatum
		Alyssum desertorum
		Bromus inermis
		Bromus tectorum
		Carduus nutans
		Convolvulus arvensis
		Descurainia sophia
		Elaeagnus angustifolia
		Eremopyrum triticeum
		Kochia scoparia
		Lolium perenne
		Medicago sativa
		Melilotus officinalis
		Onopordum acanthium
		Salsola tragus
		Sisymbrium altissimum
		Tragopogon dubius
		Tribulus terrestris

Appendix D, continued.

Grid cell	Land use type	Species
6	Uplands/Slopes	*Bromus tectorum*
		Erodium cicutarium
		Hordeum marinum ssp. *gussonianum*
7	Uplands/Slopes	*Agrostis capillaris*
		Alyssum desertorum
		Bromus inermis
		Bromus tectorum
		Sisymbrium altissimum
		Alyssum desertorum
8	Uplands/Slopes	*Bromus inermis*
		Bromus tectorum
		Erodium cicutarium
		Lactuca serriola
		Salsola tragus
		Sisymbrium altissimum
		Tamarix chinensis
		Tragopogon dubius
		Agrostis capillaris
9	Uplands/Slopes	*Alyssum desertorum*
		Bromus tectorum
		Erodium cicutarium
		Lactuca serriola
		Salsola tragus
		Sisymbrium altissimum
		Acroptilon repens
10	Uplands/Slopes	*Alyssum desertorum*
		Bromus tectorum
		Erodium cicutarium
		Hordeum marinum ssp. *gussonianum*
		Rumex crispus
		Salsola tragus
		Sisymbrium altissimum
		Tragopogon dubius
		Acroptilon repens
11	Uplands/Slopes	*Alopecurus pratensis*
		Alyssum desertorum
		Bromus inermis
		Bromus tectorum
		Convolvulus arvensis
		Descurainia sophia
		Kochia scoparia
		Melilotus officinalis
		Salsola tragus

Appendix D, continued.

Grid cell	Land use type	Species
		Sisymbrium altissimum
		Tragopogon dubius
		Convolvulus arvensis
12	Old Fields/Cultivated Lands	*Descurainia sophia*
		Elaeagnus angustifolia
		Kochia scoparia
		Marrubium vulgare
		Salsola tragus
		Sisymbrium altissimum
		Tribulus terrestris
13	Old Fields/Cultivated Lands	*Alopecurus pratensis*
		Asparagus officinalis
		Bromus inermis
		Bromus tectorum
		Carduus nutans
		Cirsium arvense
		Convolvulus arvensis
		Dactylis glomerata
		Descurainia sophia
		Elaeagnus angustifolia
		Erodium cicutarium
		Kochia scoparia
		Lactuca serriola
		Lepidium latifolium
		Malva neglecta
		Melilotus officinalis
		Onopordum acanthium
		Plantago lanceolata
		Rumex crispus
		Sisymbrium altissimum
		Taraxacum officinale
		Tragopogon dubius
		Ulmus pumila
14	Riparian/Floodplain	*Alopecurus pratensis*
		Bromus inermis
		Bromus tectorum
		Carduus nutans
		Cirsium arvense
		Convolvulus arvensis
		Dactylis glomerata
		Elaeagnus angustifolia
		Erodium cicutarium
		Kochia scoparia

Appendix D, continued.

Grid cell	Land use type	Species
		Lactuca serriola
		Rumex crispus
		Salsola tragus
		Sisymbrium altissimum
		Taraxacum officinale
		Thinopyrum intermedium
		Tragopogon dubius
		Verbascum thapsus
		Bromus tectorum
15	Uplands/Slopes	*Erodium cicutarium*
		Hordeum marinum ssp. *gussonianum*
		Lactuca serriola
		Salsola tragus
		Sisymbrium altissimum
16	Uplands/Slopes	*Alyssum desertorum*
		Bromus tectorum
		Erodium cicutarium
		Lactuca serriola
		Salsola tragus
		Sisymbrium altissimum
17	Uplands/Slopes	*Agrostis capillaris*
		Alyssum desertorum
		Bromus tectorum
		Erodium cicutarium
		Sisymbrium altissimum
18	Farmer's Ditch	*Alyssum desertorum*
		Bromus tectorum
		Erodium cicutarium
		Lactuca serriola
		Rumex crispus
		Salsola tragus
		Sisymbrium altissimum
19	Old Fields/Cultivated Lands	*Acroptilon repens*
		Aegilops cylindrica
		Asparagus officinalis
		Bromus inermis
		Bromus tectorum
		Cardaria draba
		Carduus nutans
		Convolvulus arvensis
		Descurainia sophia
		Elaeagnus angustifolia
		Kochia scoparia

Appendix D, continued.

Grid cell	Land use type	Species
		Medicago sativa
		Salsola tragus
		Sisymbrium altissimum
		Thinopyrum intermedium
		Ulmus pumila
20	Riparian/Floodplain	*Acroptilon repens*
		Agrostis capillaris
		Alopecurus pratensis
		Arctium minus
		Bromus inermis
		Bromus tectorum
		Carduus nutans
		Cirsium arvense
		Convolvulus arvensis
		Elaeagnus angustifolia
		Erodium cicutarium
		Kochia scoparia
		Lactuca serriola
		Marrubium vulgare
		Plantago lanceolata
		Poa compressa
		Taraxacum officinale
		Thinopyrum intermedium
		Tragopogon dubius
		Ulmus pumila
		Verbascum thapsus
21	Uplands/Slopes	*Bromus tectorum*
		Erodium cicutarium
		Hordeum marinum ssp. *gussonianum*
		Lactuca serriola
		Salsola tragus
		Sisymbrium altissimum
		Tragopogon dubius
		Bromus tectorum
		Erodium cicutarium
22	Uplands/Slopes	*Kochia scoparia*
		Salsola tragus
		Sisymbrium altissimum
		Tragopogon dubius
23	Farmer's Ditch	*Alyssum desertorum*
		Bromus tectorum
		Erodium cicutarium
		Kochia scoparia
		Rumex crispus

Appendix D, continued.

Grid cell	Land use type	Species
		Salsola tragus
		Sisymbrium altissimum
		Tragopogon dubius
24	Farmer's Ditch	*Alyssum desertorum*
		Arctium minus
		Artemisia absinthium
		Bromus catharticus
		Bromus tectorum
		Carduus nutans
		Ceratocephala testiculata
		Convolvulus arvensis
		Dactylis glomerata
		Descurainia sophia
		Elaeagnus angustifolia
		Erodium cicutarium
		Kochia scoparia
		Lactuca serriola
		Lepidium latifolium
		Malva neglecta
		Melilotus officinalis
		Onopordum acanthium
		Plantago lanceolata
		Rumex crispus
		Salsola tragus
		Sisymbrium altissimum
		Taraxacum officinale
		Thinopyrum intermedium
		Tragopogon dubius
		Ulmus pumila
		Verbascum thapsus
25	Old Fields/Cultivated Lands	*Acroptilon repens*
		Bromus inermis
		Bromus tectorum
		Convolvulus arvensis
		Descurainia sophia
		Elaeagnus angustifolia
		Eremopyrum triticeum
		Erodium cicutarium
		Kochia scoparia
		Lactuca serriola
		Malva neglecta
		Marrubium vulgare
		Salsola tragus
		Sisymbrium altissimum

Appendix D, continued.

Grid cell	Land use type	Species
		Thinopyrum intermedium
		Tragopogon dubius
		Ulmus pumila
26	Orchards	*Bromus inermis*
		Bromus japonicus
		Bromus tectorum
		Cardaria draba
		Carduus nutans
		Cichorium intybus
		Cirsium arvense
		Convolvulus arvensis
		Dactylis glomerata
		Descurainia sophia
		Elaeagnus angustifolia
		Erodium cicutarium
		Kochia scoparia
		Lactuca serriola
		Malva neglecta
		Marrubium vulgare
		Medicago sativa
		Plantago lanceolata
		Salsola tragus
		Sisymbrium altissimum
		Taraxacum officinale
		Thinopyrum intermedium
		Ulmus pumila
		Verbascum thapsus
27	Old Fields/Cultivated Lands	*Bromus inermis*
		Bromus tectorum
		Cichorium intybus
		Convolvulus arvensis
		Convolvulus arvensis
		Dactylis glomerata
		Descurainia sophia
		Elaeagnus angustifolia
		Erodium cicutarium
		Kochia scoparia
		Onopordum acanthium
		Salsola tragus
		Sisymbrium altissimum
		Tamarix chinensis
		Thinopyrum intermedium
		Tragopogon dubius
		Ulmus pumila

Appendix D, continued.

Grid cell	Land use type	Species
28	Old Fields/Cultivated Lands	*Acroptilon repens*
		Bromus inermis
		Bromus tectorum
		Bromus tectorum
		Cardaria draba
		Convolvulus arvensis
		Descurainia sophia
28	Old Fields/Cultivated Lands	*Elaeagnus angustifolia*
		Kochia scoparia
		Medicago sativa
		Onopordum acanthium
		Poa pratensis
		Salsola tragus
		Sisymbrium altissimum
		Tamarix chinensis
		Thinopyrum intermedium
		Tragopogon dubius
		Ulmus pumila
29	Riparian/Floodplain	*Acroptilon repens*
		Asparagus officinalis
		Bromus inermis
		Bromus tectorum
		Carduus nutans
		Cirsium arvense
		Convolvulus arvensis
		Elaeagnus angustifolia
		Kochia scoparia
		Malva neglecta
		Plantago lanceolata
		Plantago lanceolata
		Taraxacum officinale
		Thinopyrum intermedium
		Tragopogon dubius
		Verbascum thapsus
30	Uplands/Slopes	*Bromus tectorum*
		Erodium cicutarium
		Hordeum marinum ssp. *gussonianum*
		Lactuca serriola
		Salsola tragus
		Sisymbrium altissimum
31	Uplands/Slopes	*Alyssum desertorum*
		Bromus tectorum
		Erodium cicutarium
		Lactuca serriola

Appendix D, continued.

Grid cell	Land use type	Species
		Salsola tragus
		Sisymbrium altissimum
32	Farmer's Ditch	*Alyssum desertorum*
		Bromus inermis
		Bromus tectorum
		Erodium cicutarium
		Lactuca serriola
		Melilotus officinalis
		Salsola tragus
		Sisymbrium altissimum
		Tragopogon dubius
33	Uplands/Slopes	*Alyssum desertorum*
		Bromus tectorum
		Erodium cicutarium
		Hordeum marinum ssp. *gussonianum*
		Kochia scoparia
		Salsola tragus
		Sisymbrium altissimum
34	Farmer's Ditch	*Bromus inermis*
		Bromus tectorum
		Convolvulus arvensis
		Elaeagnus angustifolia
		Erodium cicutarium
		Hordeum marinum ssp. *gussonianum*
		Kochia scoparia
		Salsola tragus
		Sisymbrium altissimum
		Tamarix chinensis
		Tragopogon dubius
35	Farmer's Ditch	*Acroptilon repens*
		Agropyron cristatum
		Agrostis capillaris
		Asparagus officinalis
		Bromus tectorum
		Carduus nutans
		Convolvulus arvensis
		Elaeagnus angustifolia
		Kochia scoparia
		Lactuca serriola
		Medicago sativa
		Melilotus alba
		Plantago lanceolata
		Salsola tragus
		Sisymbrium altissimum

Appendix D, continued.

Grid cell	Land use type	Species
36	Orchards	*Agrostis capillaris*
		Alopecurus pratensis
		Arctium minus
		Asparagus officinalis
		Bromus inermis
		Bromus tectorum
		Carduus nutans
		Cichorium intybus
		Cirsium arvense
		Dactylis glomerata
		Elaeagnus angustifolia
		Erodium cicutarium
		Kochia scoparia
		Lactuca serriola
		Malva neglecta
		Medicago sativa
		Phleum pratense
		Plantago lanceolata
		Poa compressa
		Poa pratensis
		Rumex crispus
		Salsola tragus
		Sisymbrium altissimum
		Taraxacum officinale
		Thinopyrum intermedium
		Tragopogon dubius
		Ulmus pumila
		Verbascum thapsus
37	Core Cultural Area	*Alyssum desertorum*
		Bromus tectorum
		Cardaria draba
		Carduus nutans
		Cichorium intybus
		Convolvulus arvensis
		Descurainia sophia
		Eremopyrum triticeum
		Erodium cicutarium
		Kochia scoparia
		Lactuca serriola
		Medicago sativa
		Melilotus officinalis
		Plantago lanceolata
		Polygonum aviculare
		Salsola tragus

Appendix D, continued.

Grid cell	Land use type	Species
		Sisymbrium altissimum
		Taraxacum officinale
		Thinopyrum intermedium
		Tragopogon dubius
		Tribulus terrestris
		Ulmus pumila
38	Old Fields/Cultivated Lands	*Asparagus officinalis*
		Bromus inermis
		Bromus tectorum
		Carduus nutans
		Cirsium arvense
		Descurainia sophia
		Elaeagnus angustifolia
		Eremopyrum triticeum
		Erodium cicutarium
		Kochia scoparia
		Lactuca serriola
		Salsola tragus
		Sisymbrium altissimum
		Thinopyrum intermedium
		Tragopogon dubius
39	Riparian/Floodplain	*Acroptilon repens*
		Asparagus officinalis
		Bromus inermis
		Bromus tectorum
		Carduus nutans
		Convolvulus arvensis
		Elaeagnus angustifolia
		Erodium cicutarium
		Salsola tragus
		Sisymbrium altissimum
		Thinopyrum intermedium
		Tragopogon dubius
		Ulmus pumila
		Verbascum thapsus
40	Old Fields/Cultivated Lands	*Acroptilon repens*
		Aegilops cylindrica
		Asparagus officinalis
		Bromus japonicus
		Bromus tectorum
		Carduus nutans
		Convolvulus arvensis
		Dactylis glomerata
		Descurainia sophia

Appendix D, continued.

Grid cell	Land use type	Species
		Elaeagnus angustifolia
		Erodium cicutarium
		Kochia scoparia
		Medicago lupulina
		Medicago sativa
		Melilotus officinalis
		Salsola tragus
		Sisymbrium altissimum
		Thinopyrum intermedium
		Tragopogon dubius
41	Riparian/Floodplain	*Agrostis capillaris*
		Arctium minus
		Asparagus officinalis
		Bromus inermis
		Carduus nutans
		Cirsium arvense
		Convolvulus arvensis
		Dactylis glomerata
		Elaeagnus angustifolia
		Erodium cicutarium
		Melilotus officinalis
		Plantago lanceolata
		Tamarix chinensis
		Thinopyrum intermedium
		Tragopogon dubius
		Ulmus pumila
		Verbascum thapsus
42	Uplands/Slopes	*Acroptilon repens*
		Bromus tectorum
		Erodium cicutarium
		Onopordum acanthium
		Salsola tragus
		Tragopogon dubius
43	Farmer's Ditch	*Acroptilon repens*
		Agropyron cristatum
		Alyssum desertorum
		Asparagus officinalis
		Bromus inermis
		Bromus tectorum
		Convolvulus arvensis
		Descurainia sophia
		Elaeagnus angustifolia
		Erodium cicutarium
		Kochia scoparia

Appendix D, continued.

Grid cell	Land use type	Species
		Medicago sativa
		Salsola tragus
		Sisymbrium altissimum
		Thinopyrum intermedium
		Tragopogon dubius
		Ulmus pumila
44	Old Fields/Cultivated Lands	*Bromus inermis*
		Carduus nutans
		Cichorium intybus
		Convolvulus arvensis
		Descurainia sophia
		Elaeagnus angustifolia
		Erodium cicutarium
		Hibiscus trionum
		Kochia scoparia
		Malva neglecta
		Medicago sativa
		Morus alba
		Salsola tragus
		Sisymbrium altissimum
		Thinopyrum intermedium
		Ulmus pumila
45	Old Fields/Cultivated Lands	*Agrostis capillaris*
		Alopecurus pratensis
		Arctium minus
		Artemisia absinthium
		Bromus inermis
		Bromus tectorum
		Carduus nutans
		Cichorium intybus
		Cirsium arvense
		Convolvulus arvensis
		Dactylis glomerata
		Elaeagnus angustifolia
		Hibiscus trionum
		Hordeum marinum ssp. *gussonianum*
		Kochia scoparia
		Lactuca serriola
		Malva neglecta
		Medicago lupulina
		Medicago sativa
		Melilotus alba
		Melilotus officinalis
		Phleum pratense

Appendix D, continued.

Grid cell	Land use type	Species
		Plantago lanceolata
		Poa compressa
		Polypogon monspeliensis
		Rumex crispus
		Salsola tragus
		Taraxacum officinale
		Thinopyrum intermedium
		Thinopyrum ponticum
		Tragopogon dubius
		Trifolium pratense
		Ulmus pumila
46	Old Fields/Cultivated Lands	*Artemisia absinthium*
		Asparagus officinalis
		Bromus inermis
		Bromus tectorum
		Cichorium intybus
		Cirsium arvense
		Convolvulus arvensis
		Dactylis glomerata
		Descurainia sophia
		Elaeagnus angustifolia
		Erodium cicutarium
		Kochia scoparia
		Medicago lupulina
		Medicago sativa
		Melilotus officinalis
		Plantago lanceolata
		Salsola tragus
		Sisymbrium altissimum
		Taraxacum officinale
		Tragopogon dubius
		Trifolium pratense
		Ulmus pumila
47	Old Fields/Cultivated Lands	*Acroptilon repens*
		Agropyron cristatum
		Artemisia absinthium
		Bromus inermis
		Bromus tectorum
		Carduus nutans
		Cichorium intybus
		Cirsium arvense
		Convolvulus arvensis
		Elaeagnus angustifolia
		Erodium cicutarium

Appendix D, continued.

Grid cell	Land use type	Species
		Kochia scoparia
		Lactuca serriola
		Medicago lupulina
		Melilotus officinalis
		Morus alba
		Plantago lanceolata
		Rumex crispus
		Salsola tragus
		Sisymbrium altissimum
		Taraxacum officinale
		Thinopyrum intermedium
		Tragopogon dubius
		Ulmus pumila
48	Old Fields/Cultivated Lands	*Agrostis capillaris*
		Arctium minus
		Bromus catharticus
		Bromus inermis
		Bromus tectorum
		Cardaria chalapensis
		Carduus nutans
		Cirsium arvense
		Convolvulus arvensis
		Descurainia sophia
		Elaeagnus angustifolia
		Kochia scoparia
		Medicago sativa
		Morus alba
		Phleum pratense
		Salsola tragus
		Sisymbrium altissimum
		Taraxacum officinale
		Thinopyrum intermedium
		Tragopogon dubius
		Ulmus pumila
49	Riparian/Floodplain	*Agrostis capillaris*
		Arctium minus
		Bromus catharticus
		Bromus inermis
		Bromus japonicus
		Cardaria chalapensis
		Carduus nutans
		Cirsium arvense
		Elaeagnus angustifolia
		Lactuca serriola

Appendix D, continued.

Grid cell	Land use type	Species
		Poa pratensis
		Tamarix chinensis
		Thinopyrum intermedium
		Tragopogon dubius
		Ulmus pumila
50	Old Fields/Cultivated Lands	*Acroptilon repens*
		Bromus inermis
		Bromus tectorum
		Convolvulus arvensis
		Eremopyrum triticeum
		Kochia scoparia
		Salsola tragus
		Sisymbrium altissimum
		Tragopogon dubius
		Ulmus pumila
51	Old Fields/Cultivated Lands	*Bromus inermis*
		Bromus tectorum
		Carduus nutans
		Convolvulus arvensis
		Elaeagnus angustifolia
		Eremopyrum triticeum
		Erodium cicutarium
		Kochia scoparia
		Medicago sativa
		Salsola tragus
		Ulmus pumila
52	Old Fields/Cultivated Lands	*Agropyron cristatum*
		Agrostis capillaris
		Artemisia absinthium
		Bromus catharticus
		Bromus inermis
		Bromus tectorum
		Carduus nutans
		Cichorium intybus
		Cirsium arvense
		Convolvulus arvensis
		Eremopyrum triticeum
		Erodium cicutarium
		Kochia scoparia
		Malva neglecta
		Medicago sativa
		Melilotus officinalis
		Plantago lanceolata
		Salsola tragus

Appendix D, continued.

Grid cell	Land use type	Species
		Sisymbrium altissimum
		Thinopyrum intermedium
		Tragopogon dubius
		Ulmus pumila
53	Old Fields/Cultivated Lands	*Artemisia absinthium*
		Asparagus officinalis
		Bromus inermis
		Bromus tectorum
		Carduus nutans
		Cichorium intybus
		Convolvulus arvensis
		Erodium cicutarium
		Kochia scoparia
		Lactuca serriola
		Malva neglecta
		Medicago lupulina
		Medicago sativa
		Plantago lanceolata
		Salsola tragus
		Sisymbrium altissimum
		Thinopyrum intermedium
		Tragopogon dubius
		Ulmus pumila
54	Uplands/Slopes	*Bromus tectorum*
		Erodium cicutarium
		Hordeum marinum ssp. *gussonianum*
		Salsola tragus
		Sisymbrium altissimum
55	Uplands/Slopes	*Bromus tectorum*
		Descurainia sophia
		Erodium cicutarium
		Hordeum marinum ssp. *gussonianum*
		Salsola tragus
		Sisymbrium altissimum
		Tragopogon dubius
56	Uplands/Slopes	*Alyssum desertorum*
		Bromus tectorum
		Cirsium arvense
		Erodium cicutarium
		Salsola tragus
		Sisymbrium altissimum

Appendix E. Exotic Plant Species Maps

Appendix E contains the maps of species occurrence for each exotic species in Aztec Ruins National Monument. The maps also show land use type by grid cells. The data used to make these maps came from the 50-m belt transect data and the grid cell data. We identified land use types by dominant species and physical land attributes. These six land use types were: Core Cultural Area (1 grid cell), Farmer's Ditch (7 grid cells), Old Fields/Cultivated Lands (18 grid cells), Orchards (2 grid cells), Riparian/Floodplain (6 grid cells), and Uplands/Slopes (22 grid cells). Each grid cell is approximately two ha (N=56). Belt transects width varied in size depending on land use type. Uplands/Slopes belt transects were four meters in width (200 m^2) and all other lowland land use types were three meters in width (150 m^2). We calculated the percent exotic cover by first calculating a midpoint for each cover class and then calculating the mean from the midpoint data (N=56).

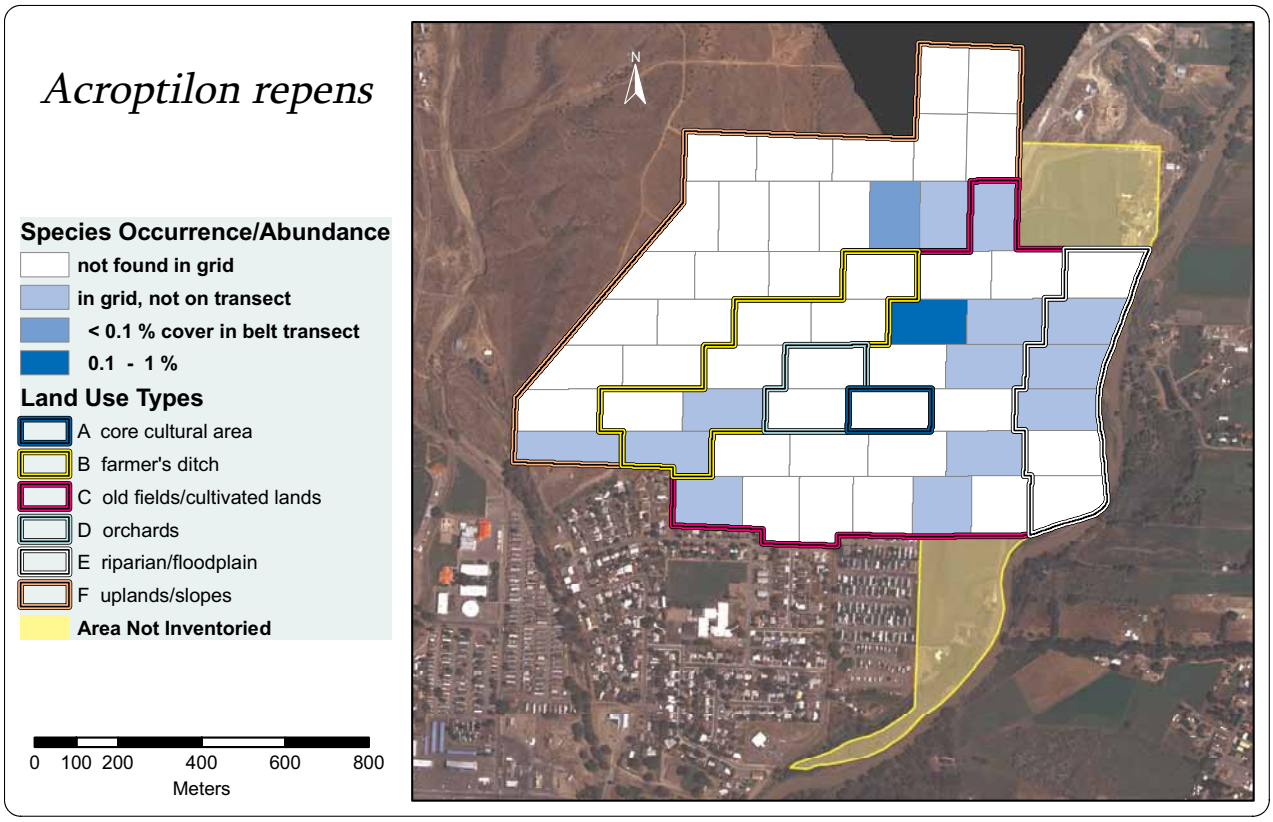

Figure E1. Species occurrence of *Acroptilon repens* by grid cell.

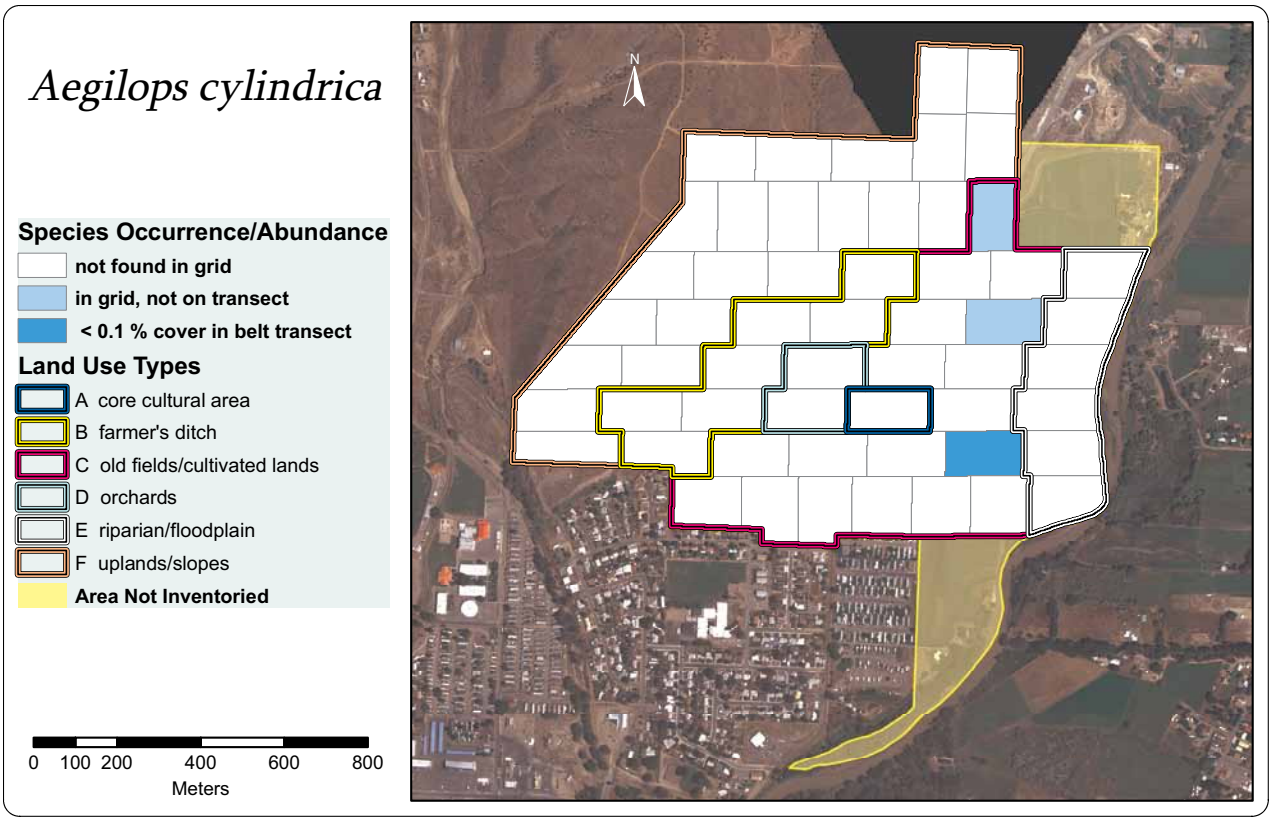

Figure E2. Species occurrence of *Aegilops cylindrica* by grid cell.

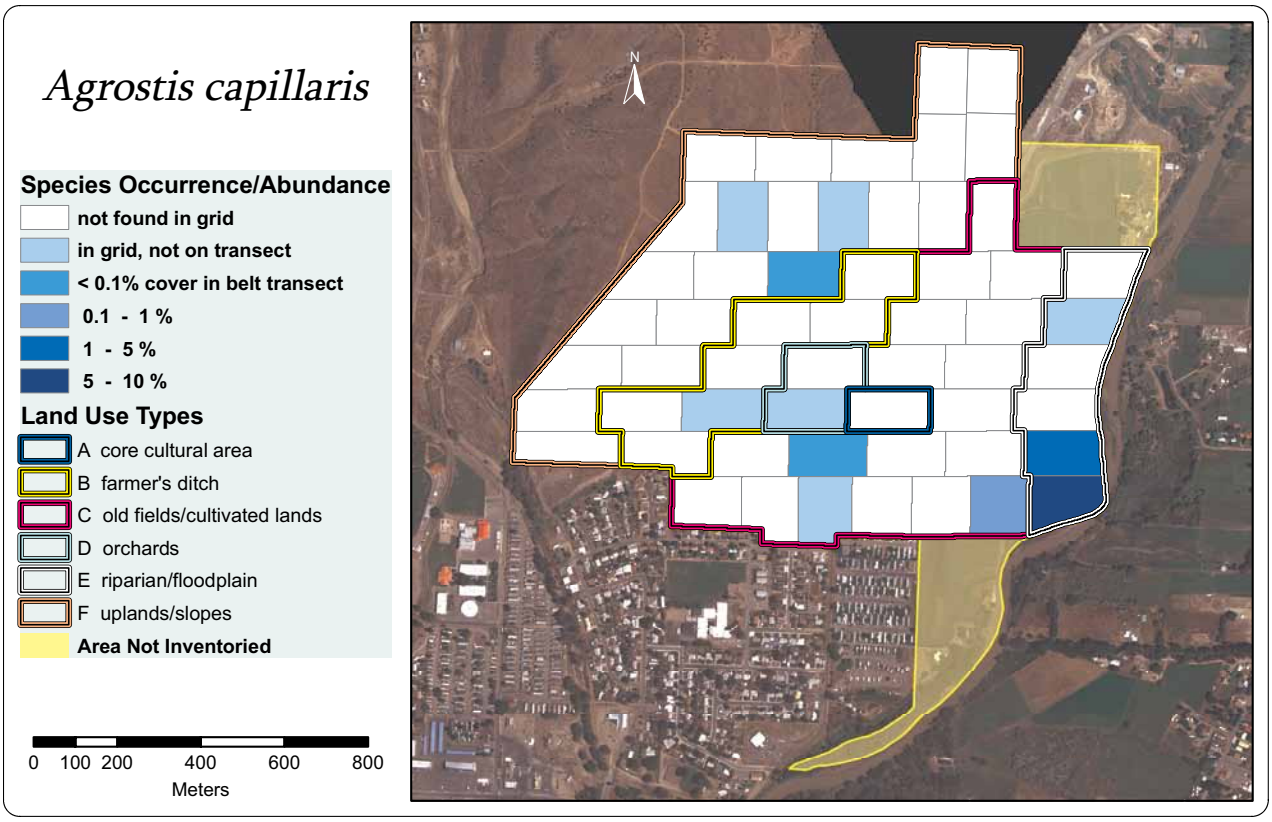

Figure E3. Species occurrence of *Agrostis capillaris* by grid cell.

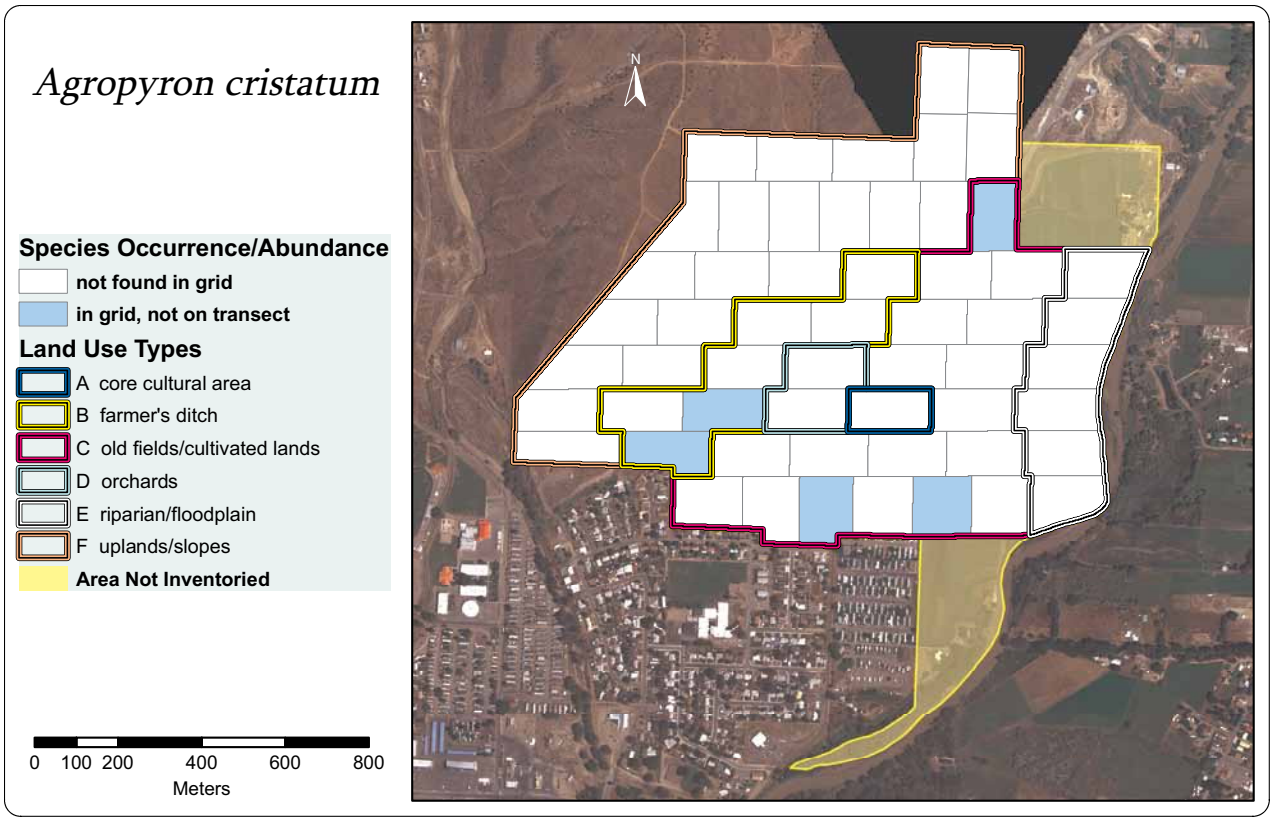

Figure E4. Species occurrence of *Agropyron cristatum* by grid cell.

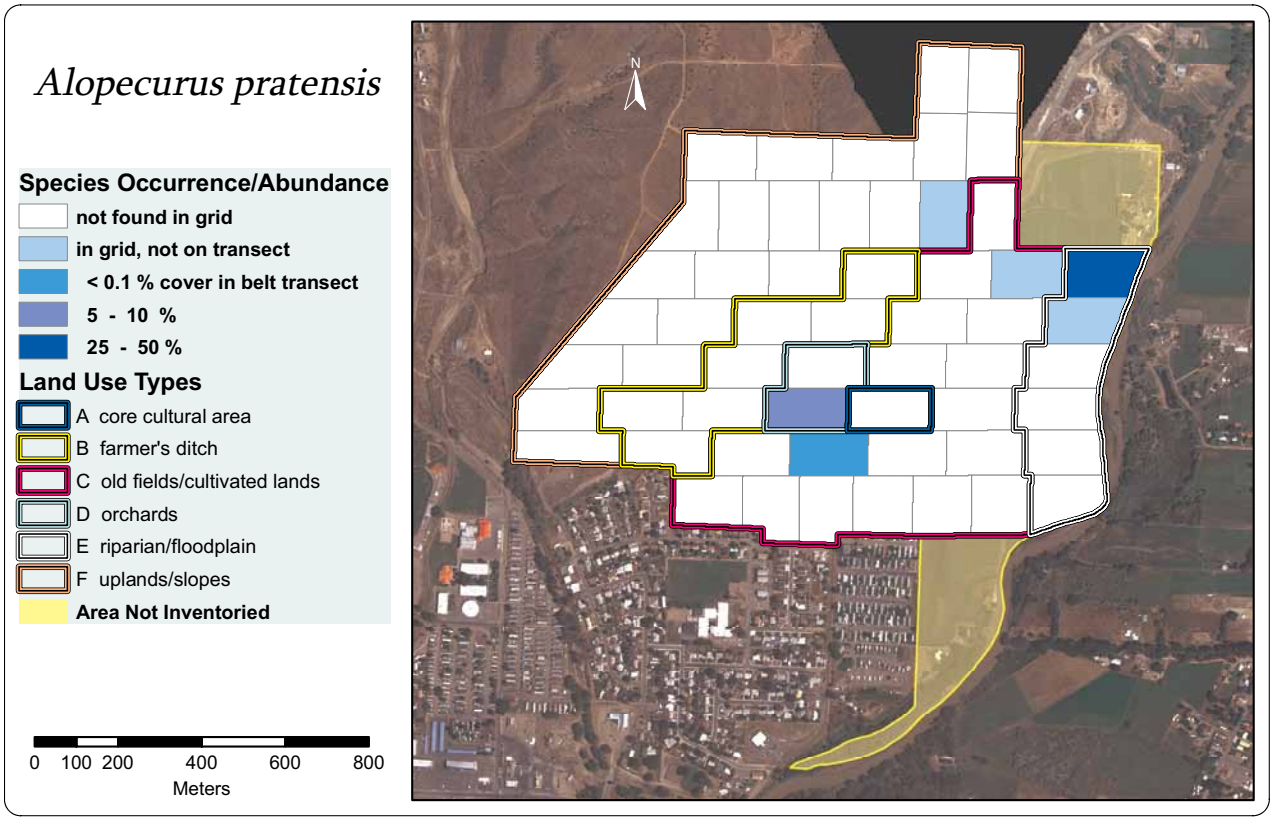

Figure E5. Species occurrence of *Alopecurus pratensis* by grid cell.

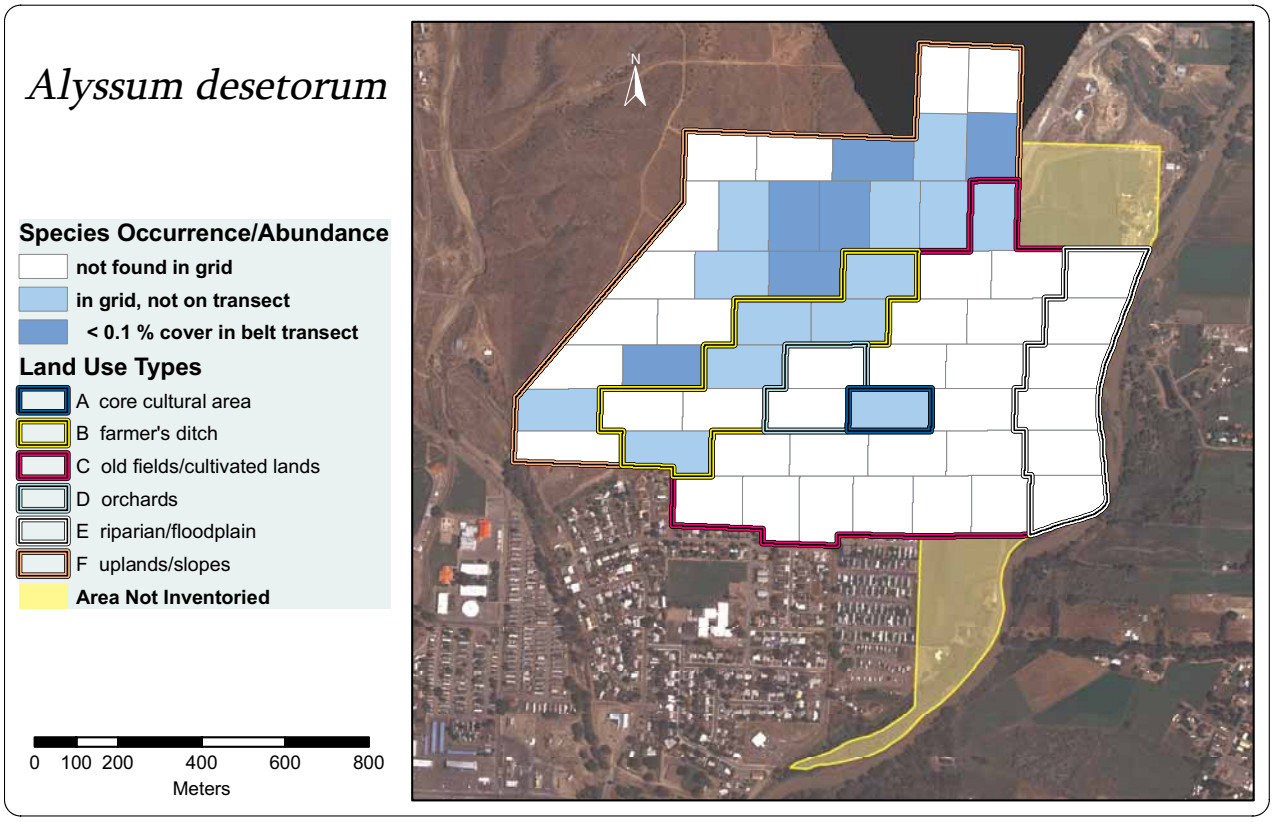

Figure E6. Species occurrence of *Alyssum desetorum* by grid cell.

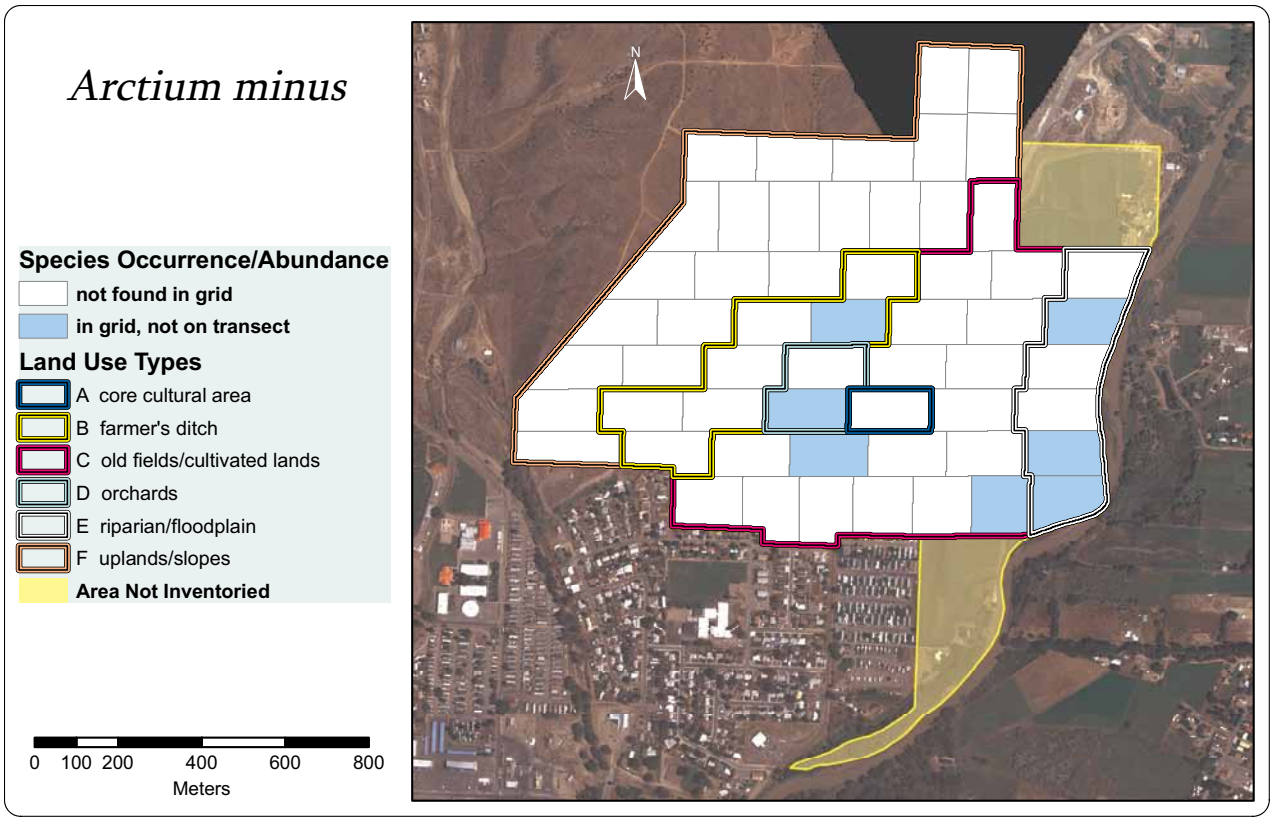

Figure E7. Species occurrence of *Arctium minus* by grid cell.

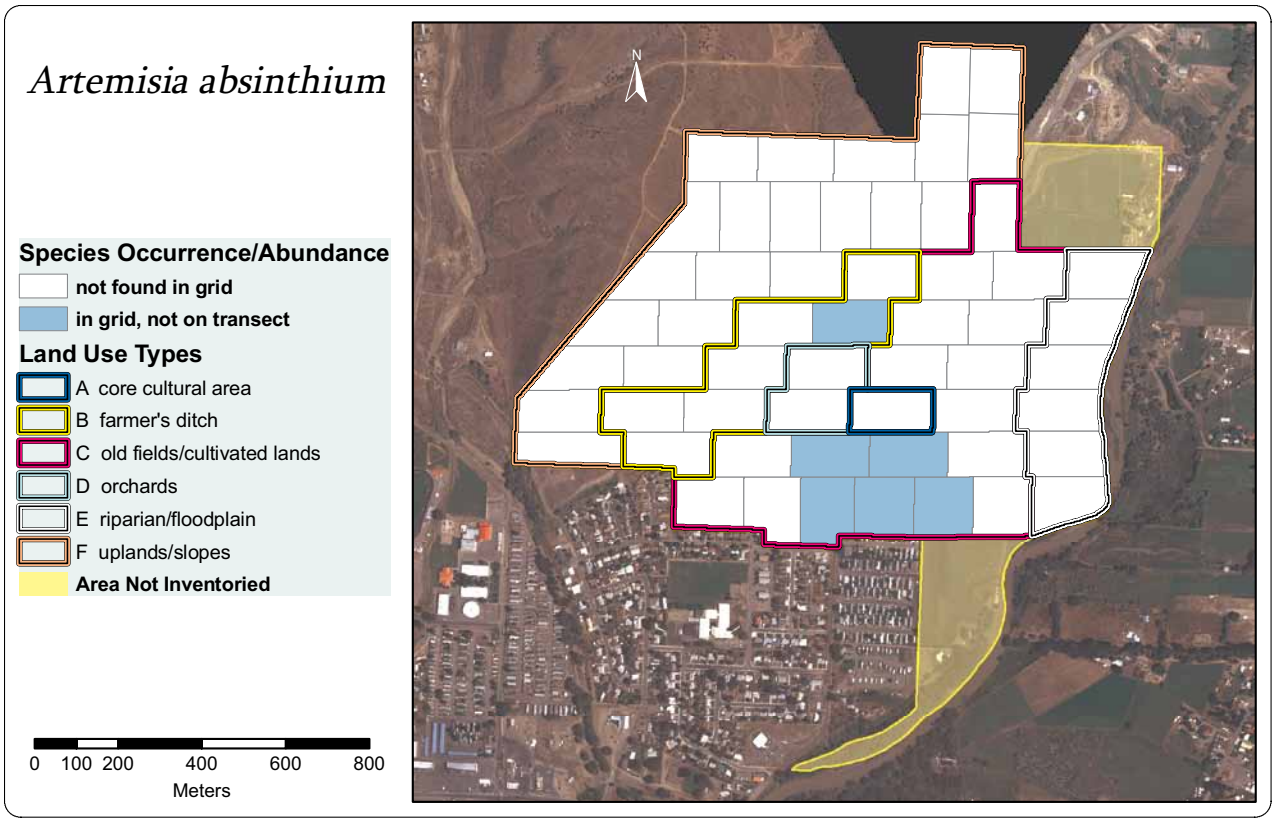

Figure E8. Species occurrence of *Artemisia absinthium* by grid cell.

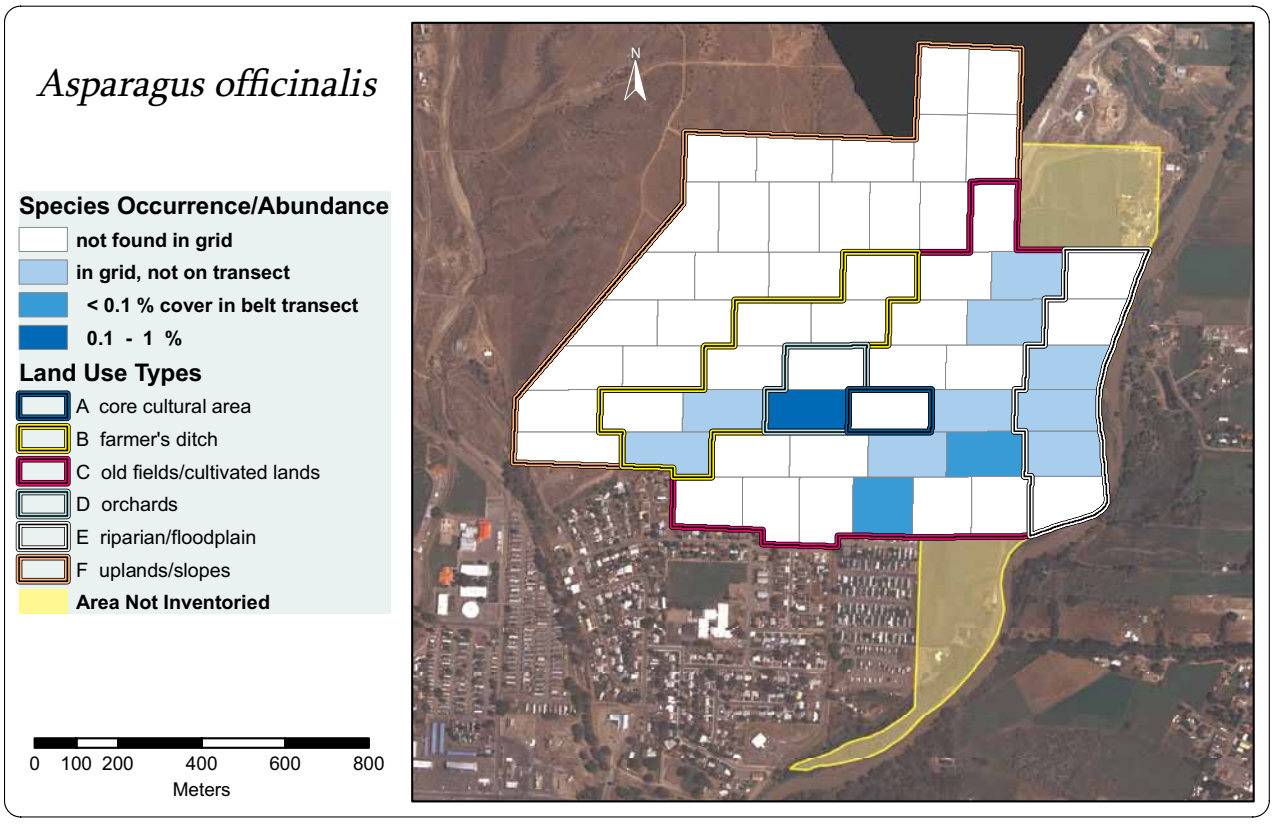

Figure E9. Species occurrence of *Asparagus officinalis* by grid cell.

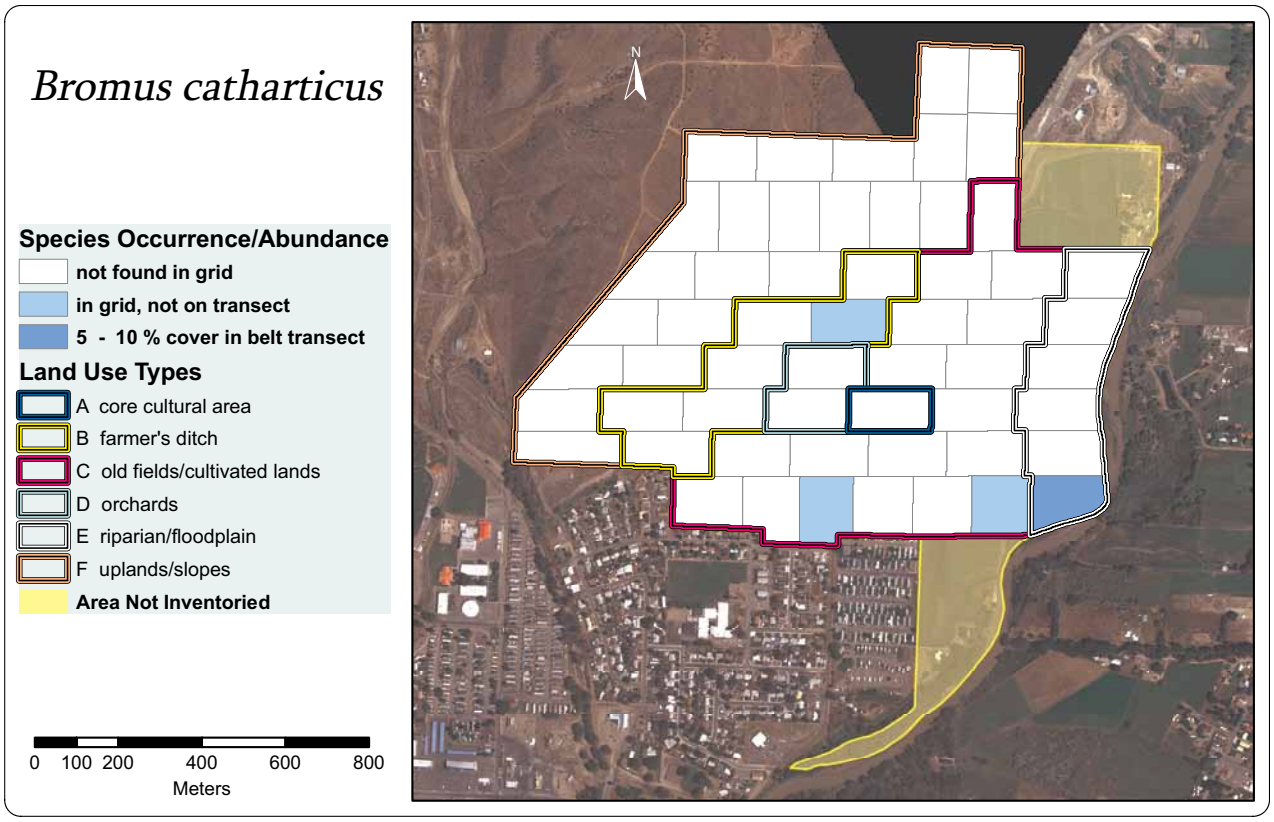

Figure E10. Species occurrence of *Bromus catharticus* by grid cell.

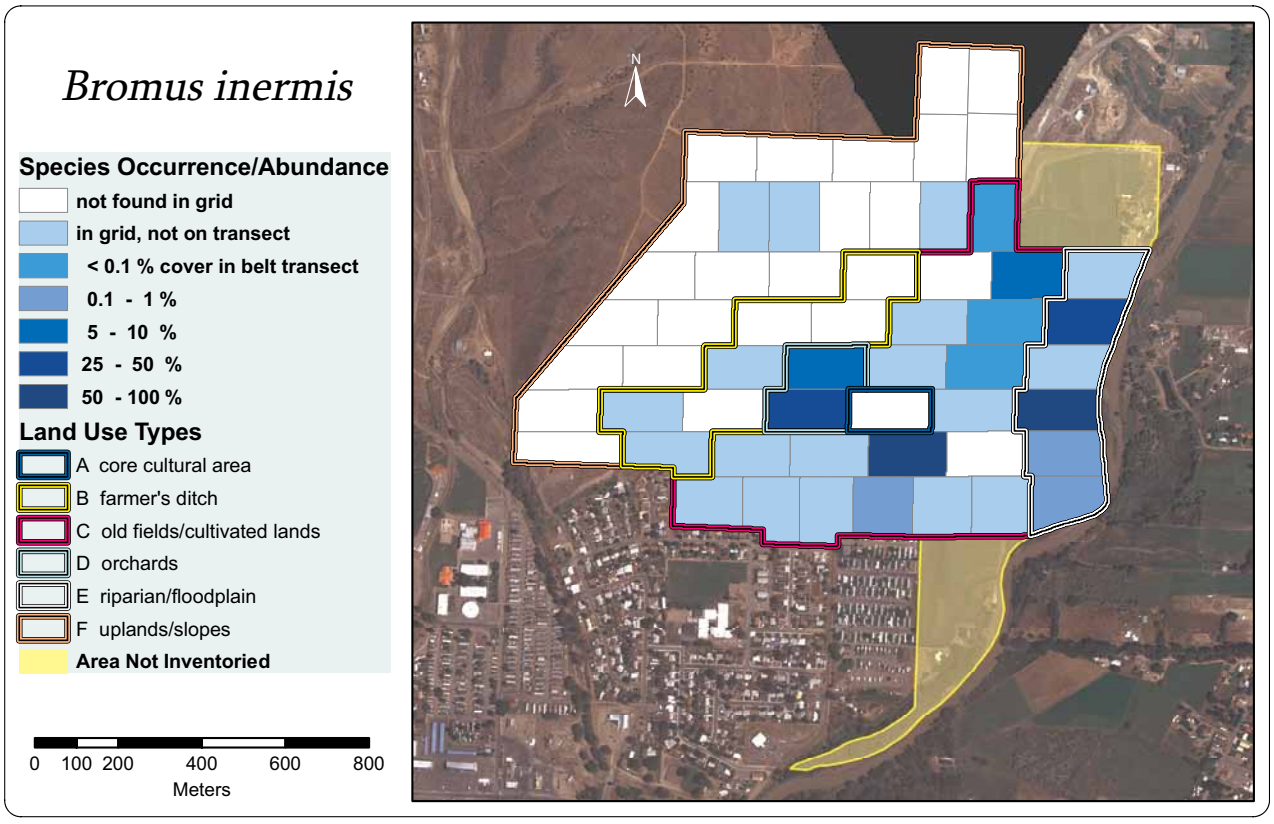

Figure E11. Species occurrence of *Bromus inermis* by grid cell.

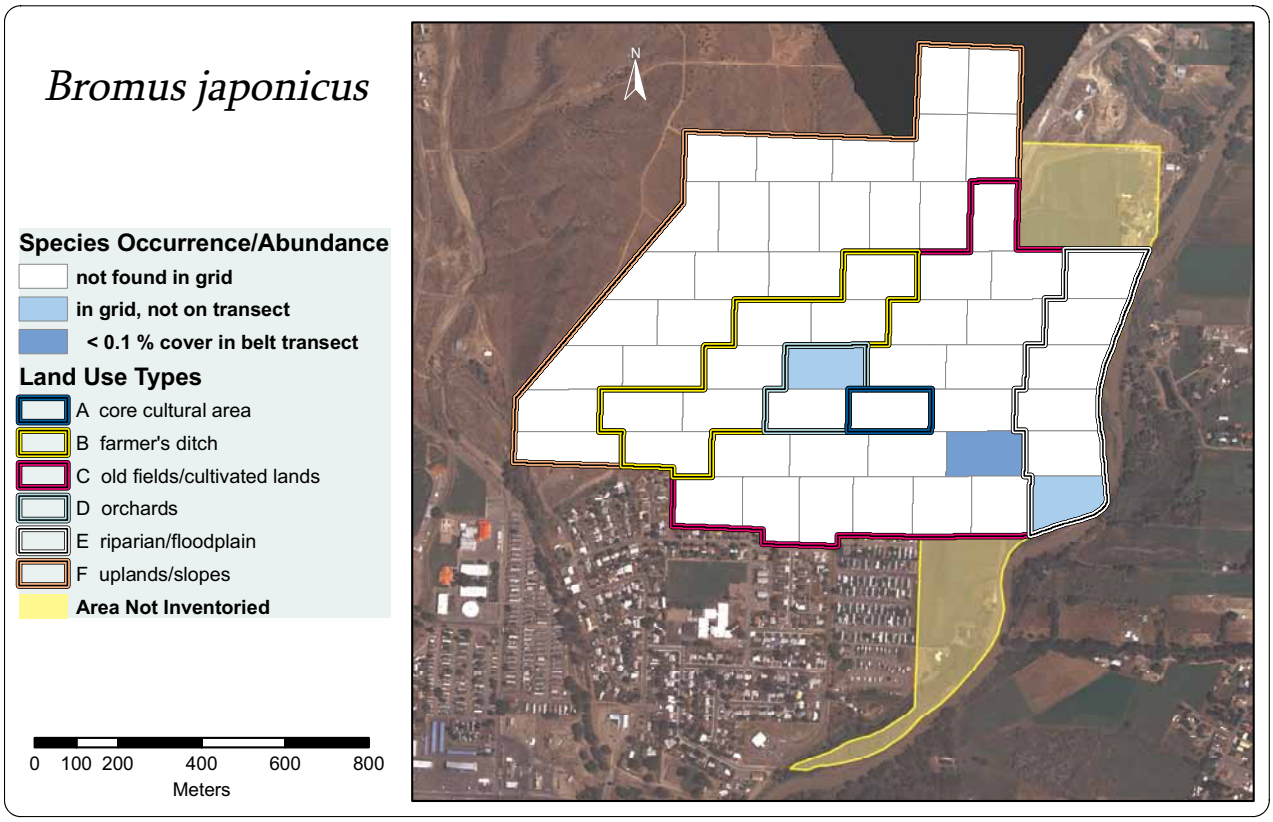

Figure E12. Species occurrence of *Bromus japonicus* by grid cell.

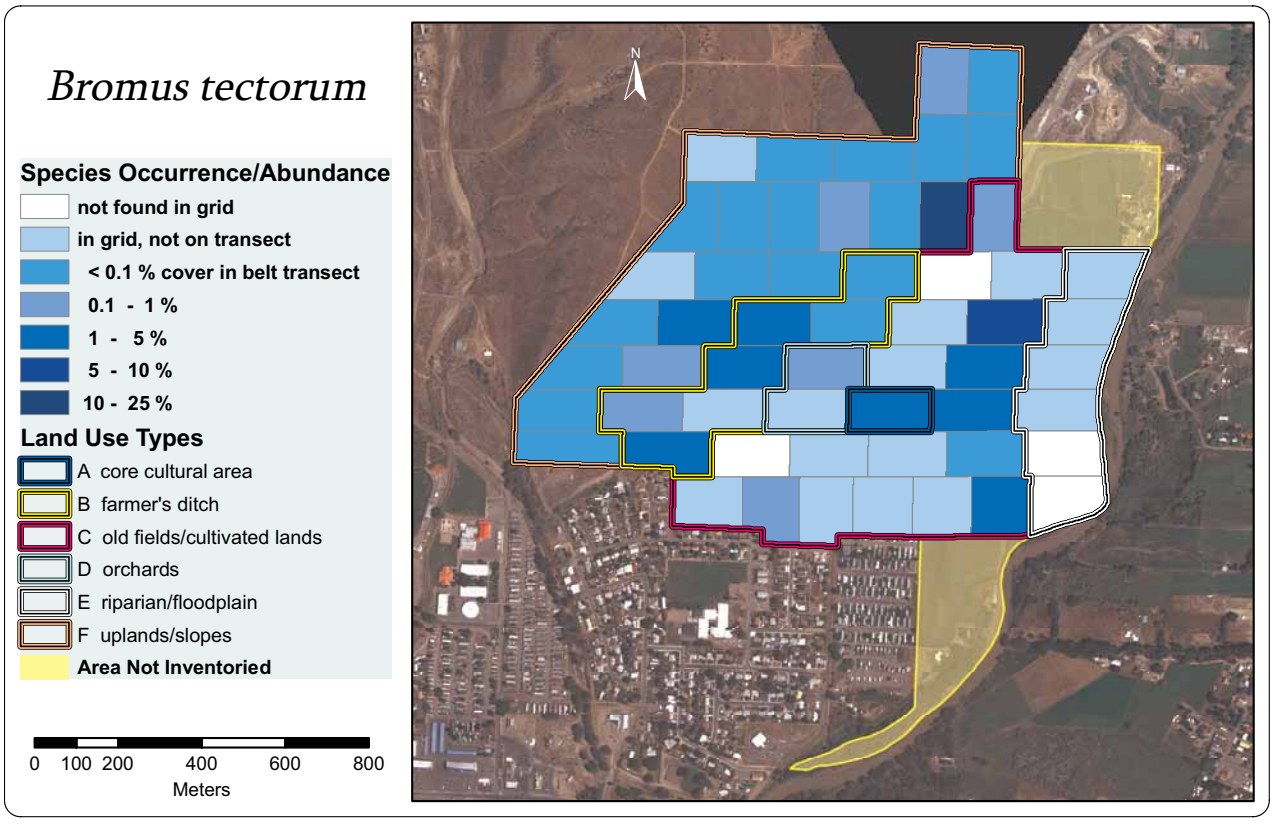

Figure E13. Species occurrence of *Bromus tectorum* by grid cell.

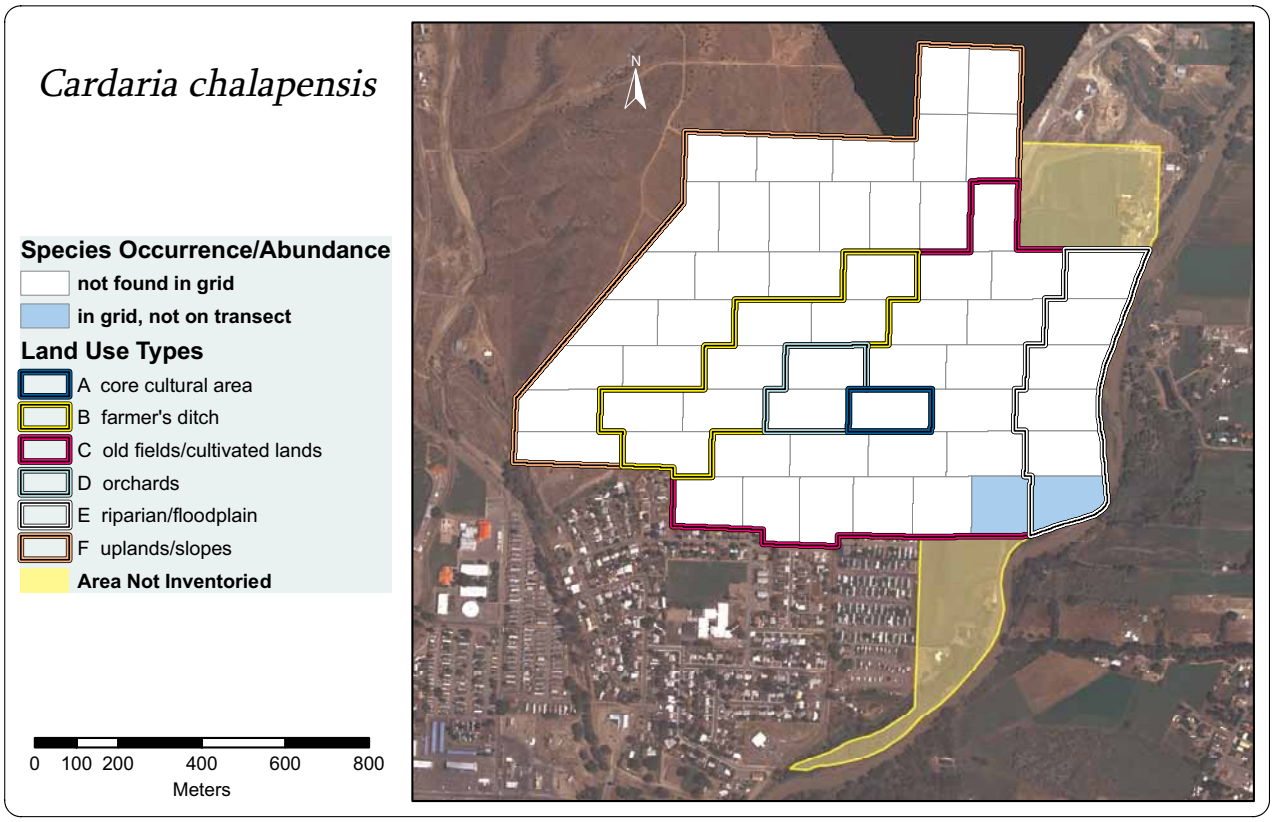

Figure E14. Species occurrence of *Cardaria chalapensis* by grid cell.

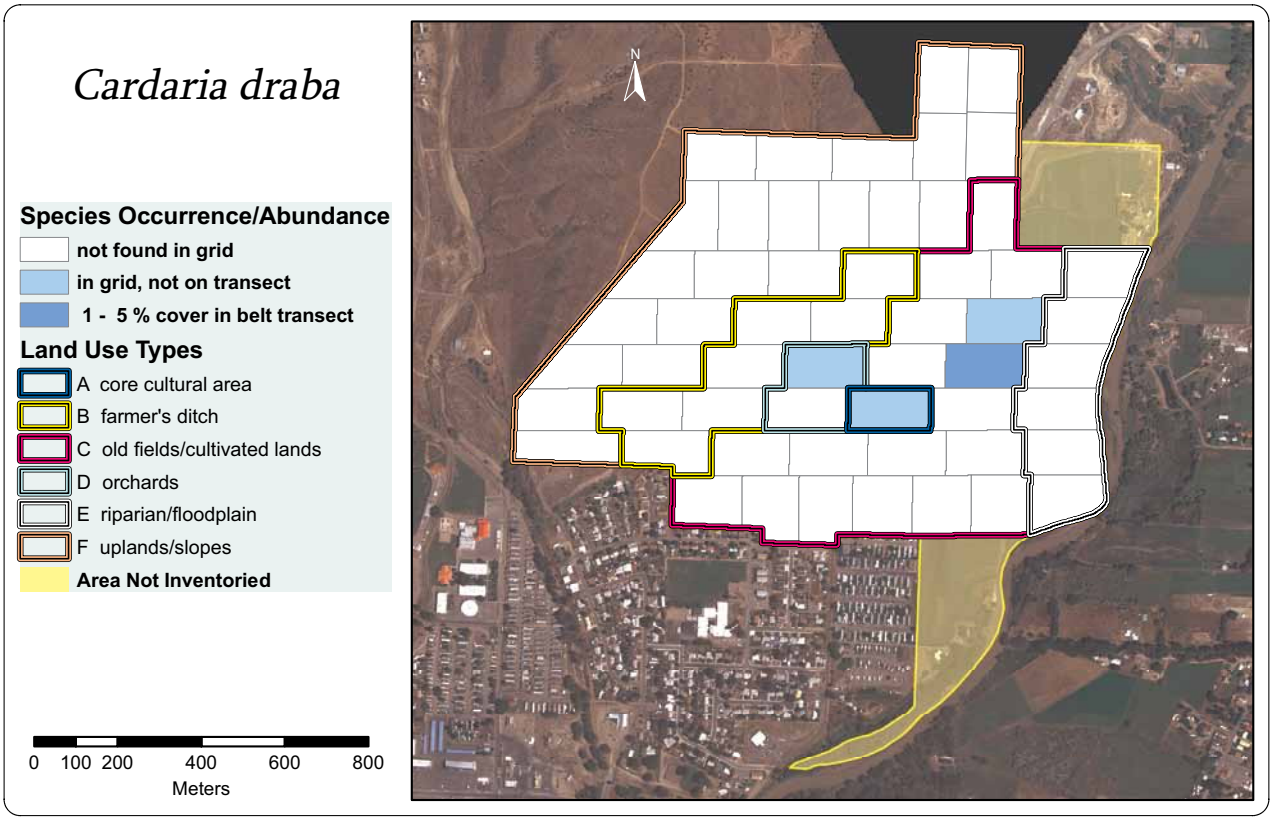

Figure E15. Species occurrence of *Cardaria draba* by grid cell.

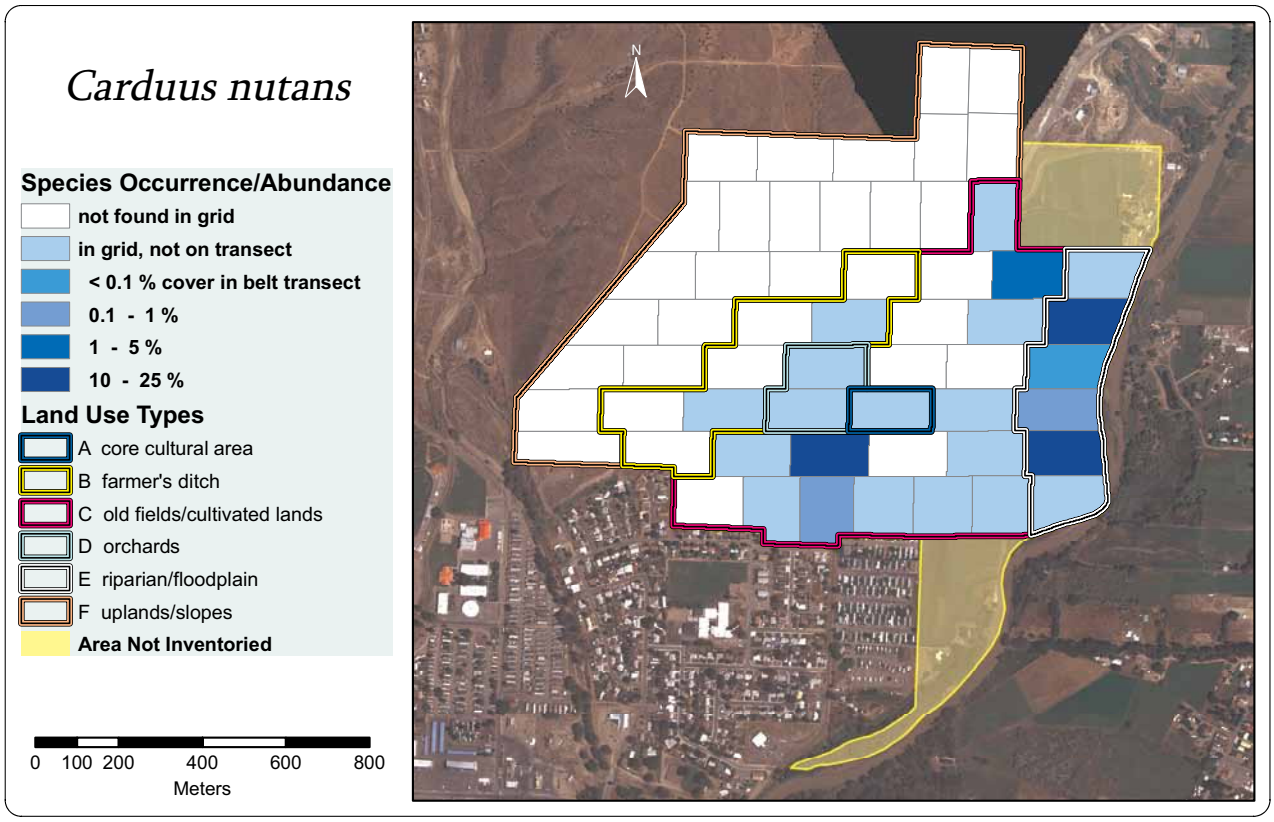

Figure E16. Species occurrence of *Carduus nutans* by grid cell.

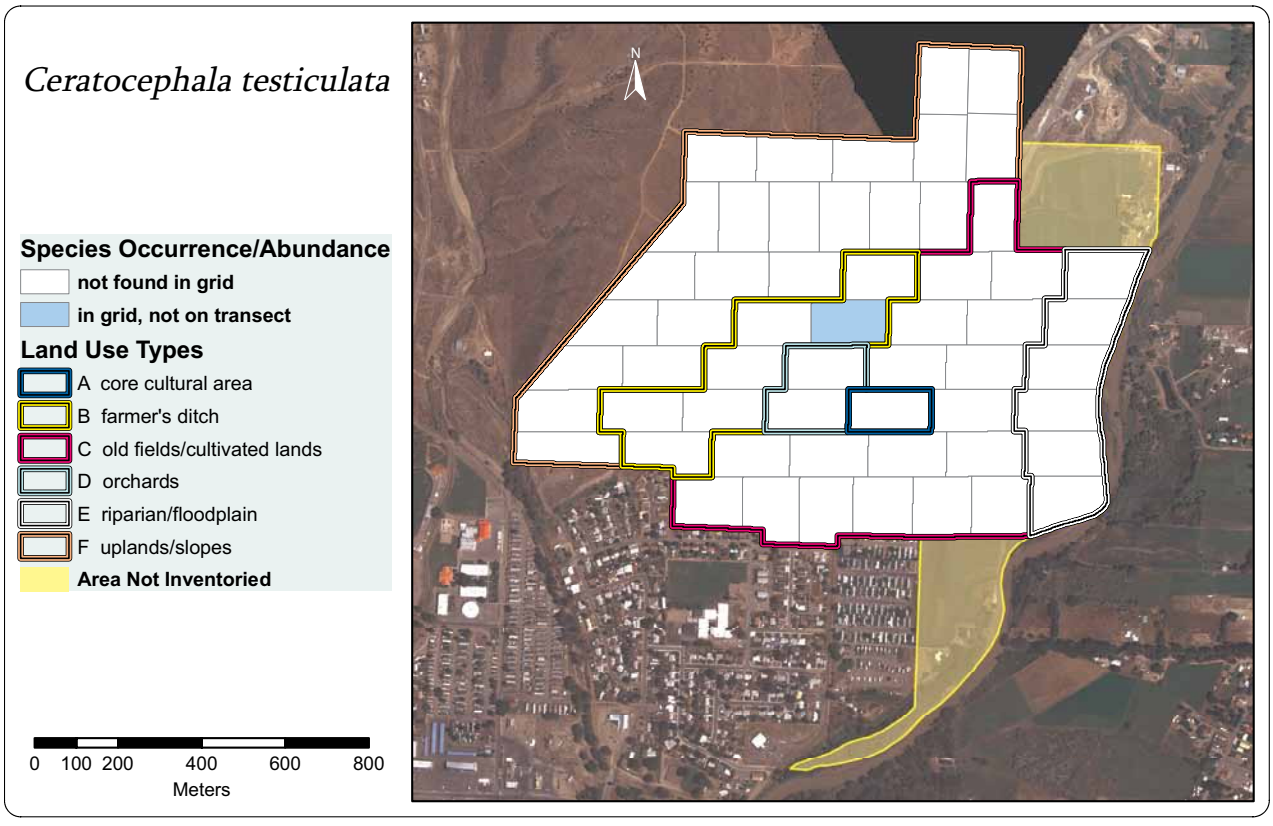

Figure E17. Species occurrence of *Ceratocephala testiculata* by grid cell.

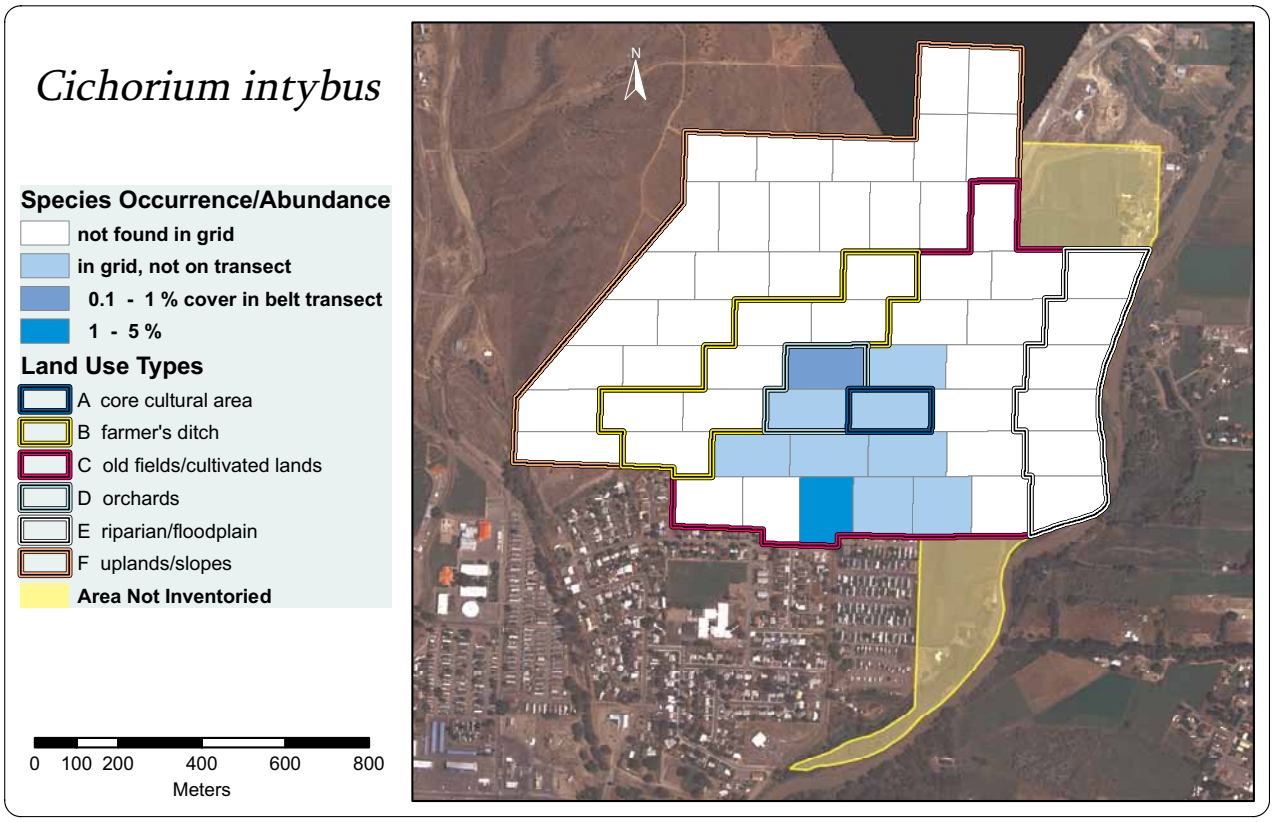

Figure E18. Species occurrence of *Cichorium intybus* by grid cell.

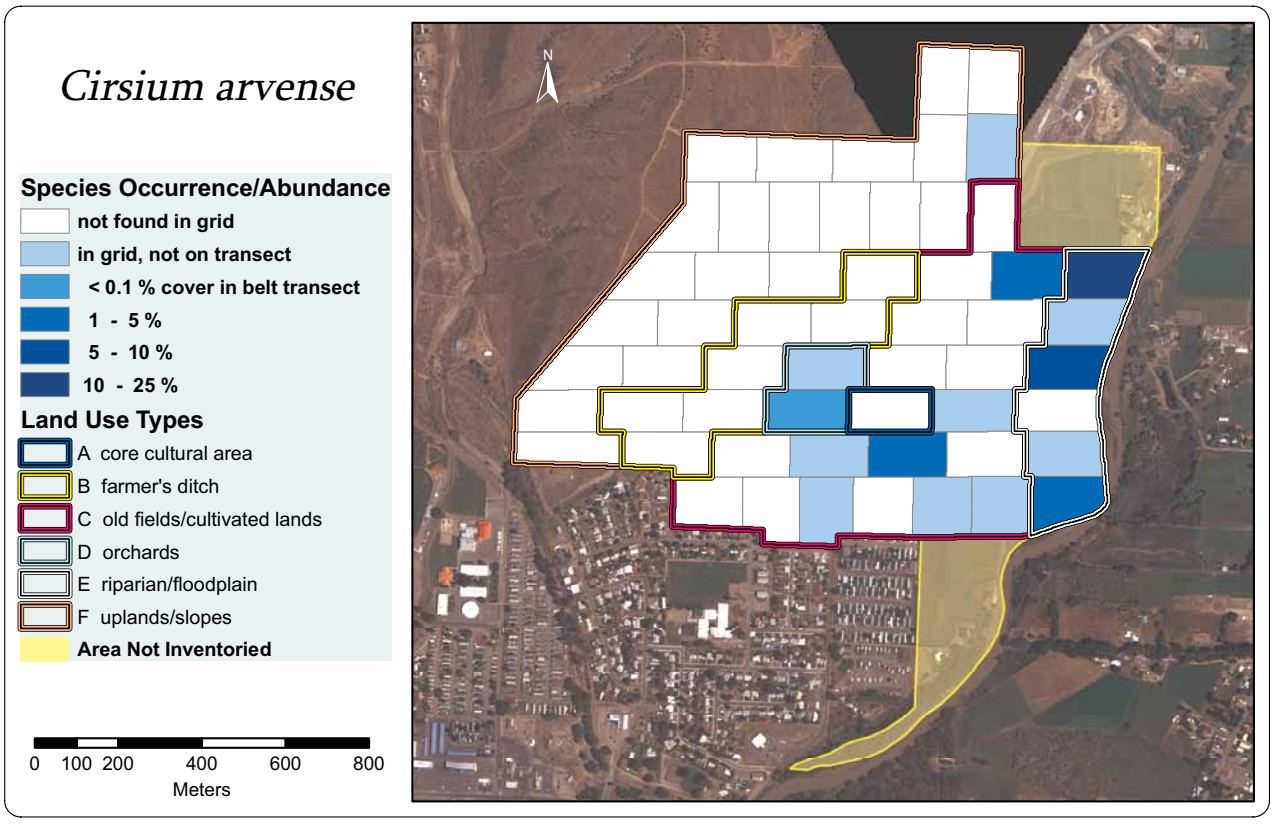

Figure E19. Species occurrence of *Cirsium arvense* by grid cell.

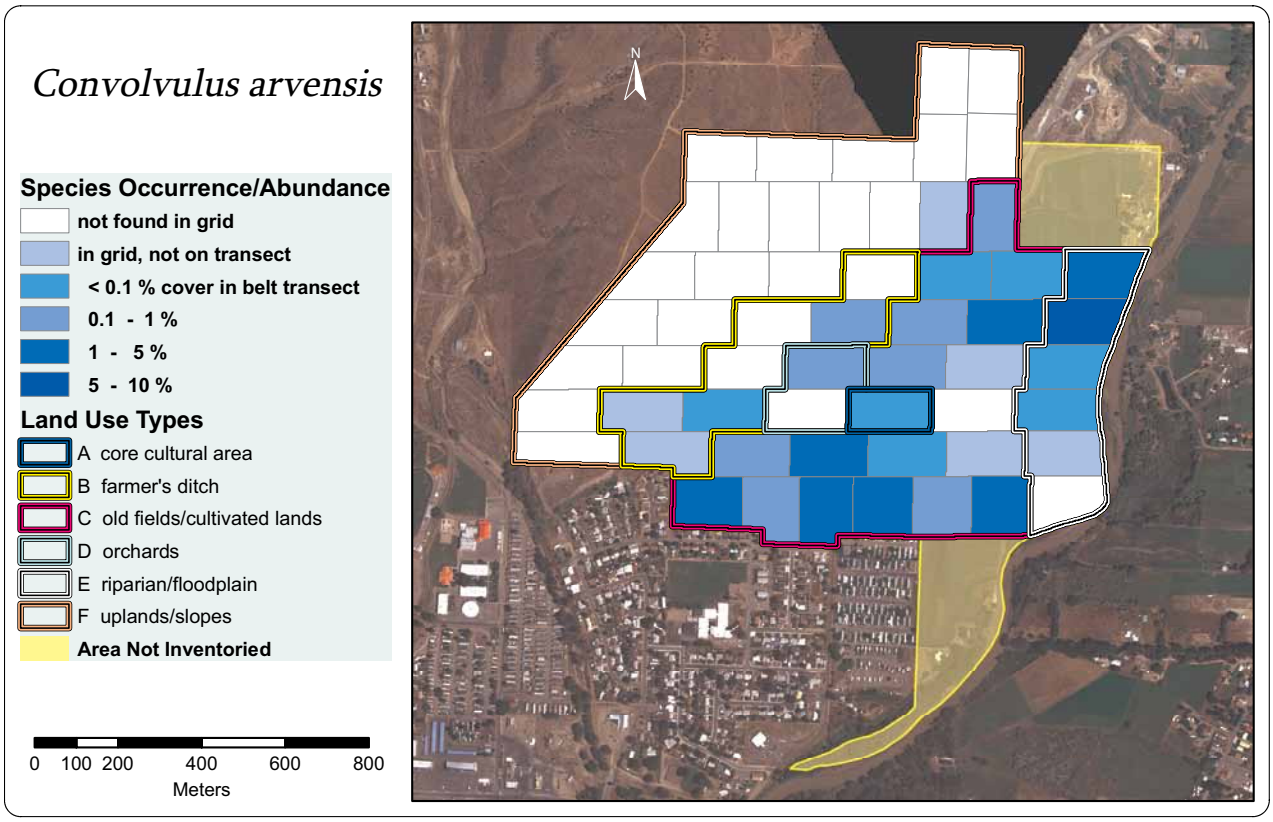

Figure E20. Species occurrence of *Convolvulus arvensis* by grid cell.

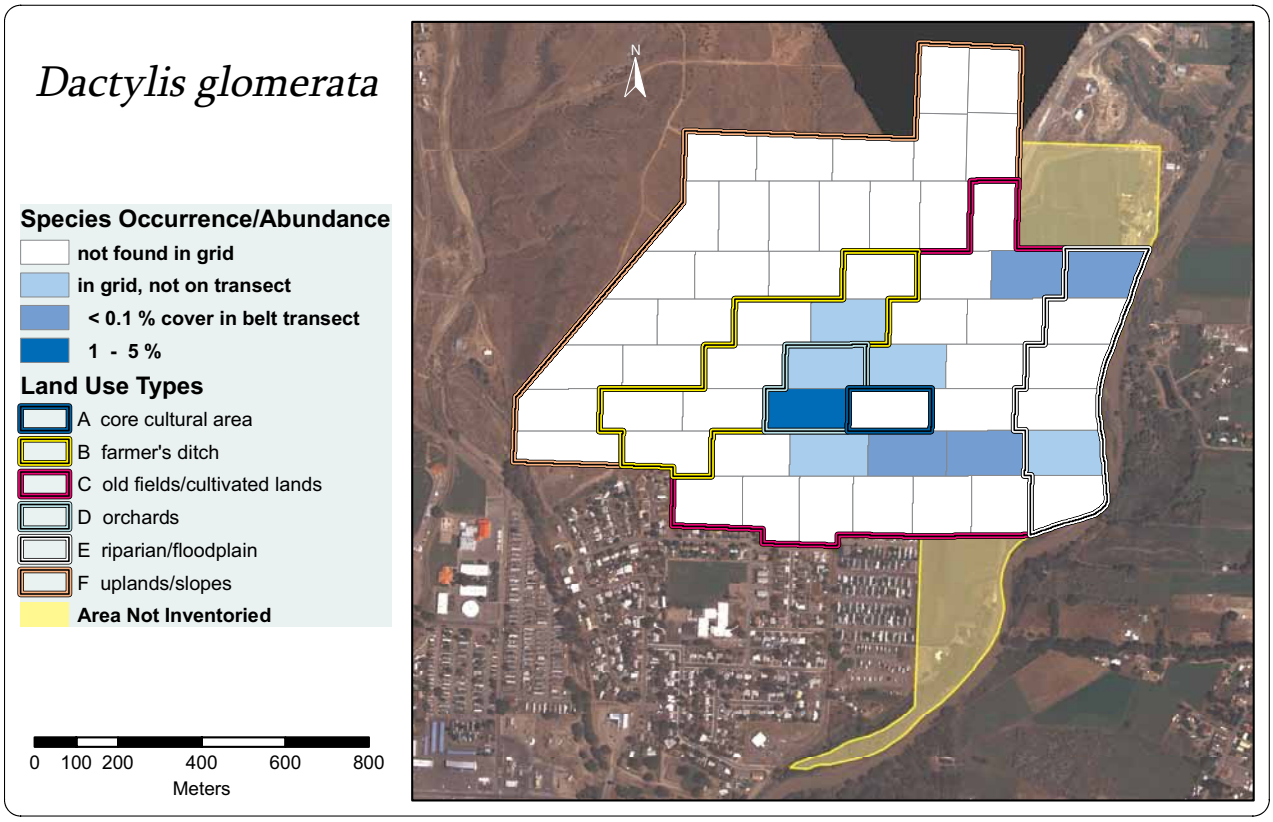

Figure E21. Species occurrence of *Dactylis glomerata* by grid cell.

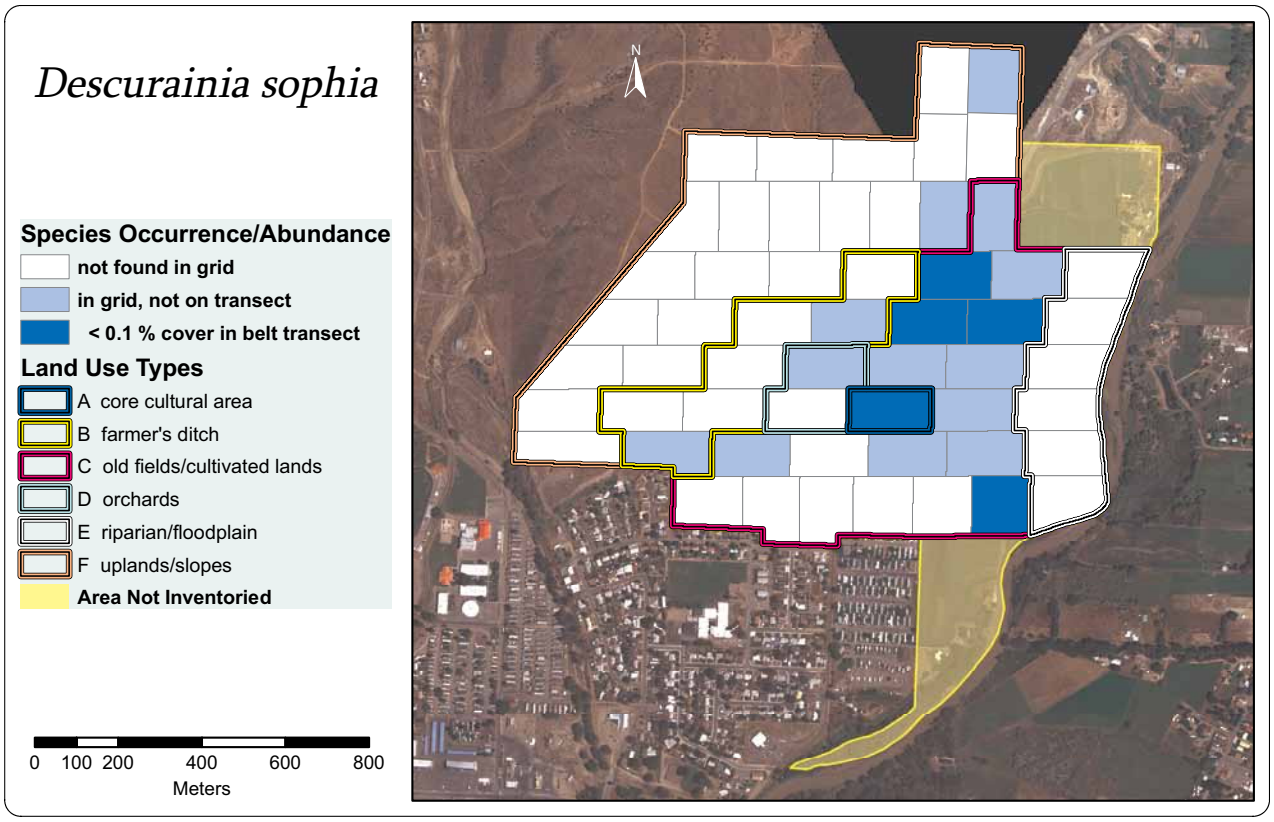

Figure E22. Species occurrence of *Descurainia sophia* by grid cell.

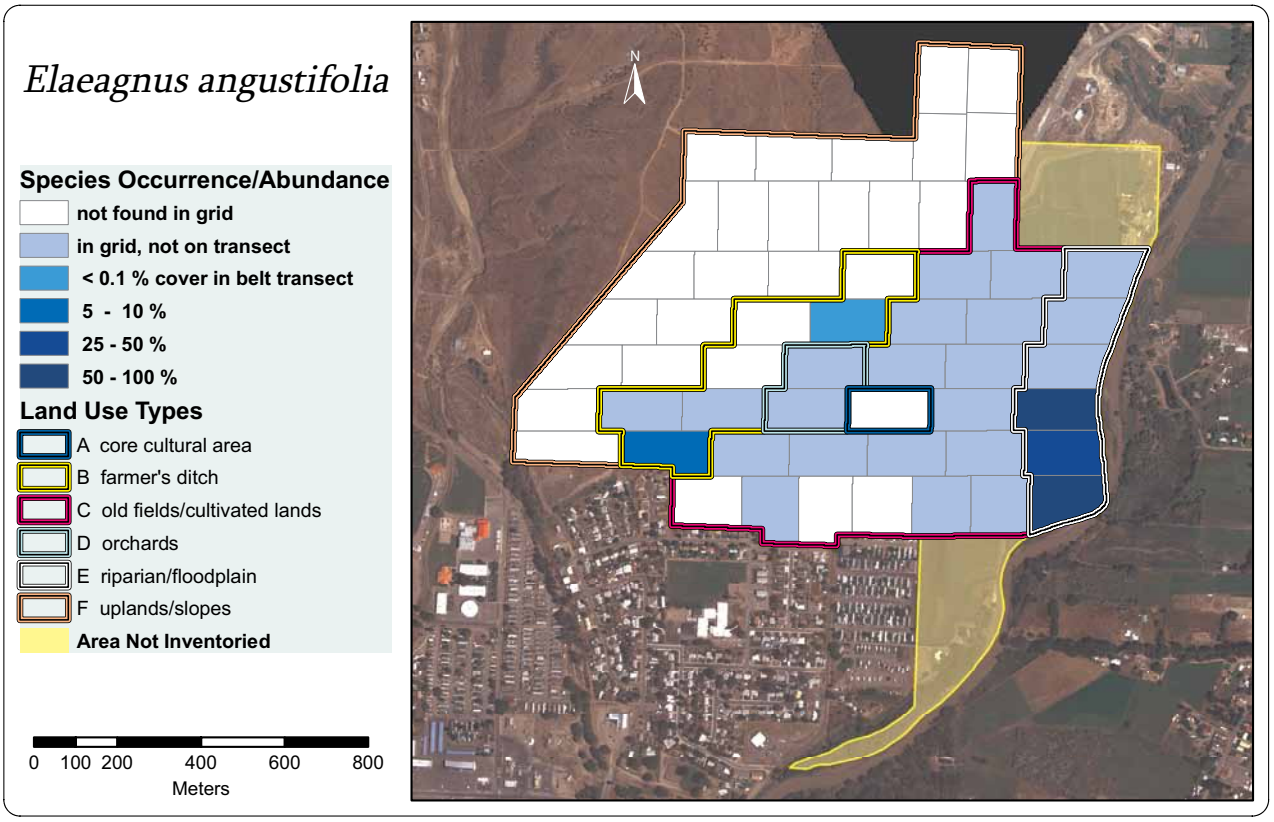

Figure E23. Species occurrence of *Elaeagnus angustifolia* by grid cell.

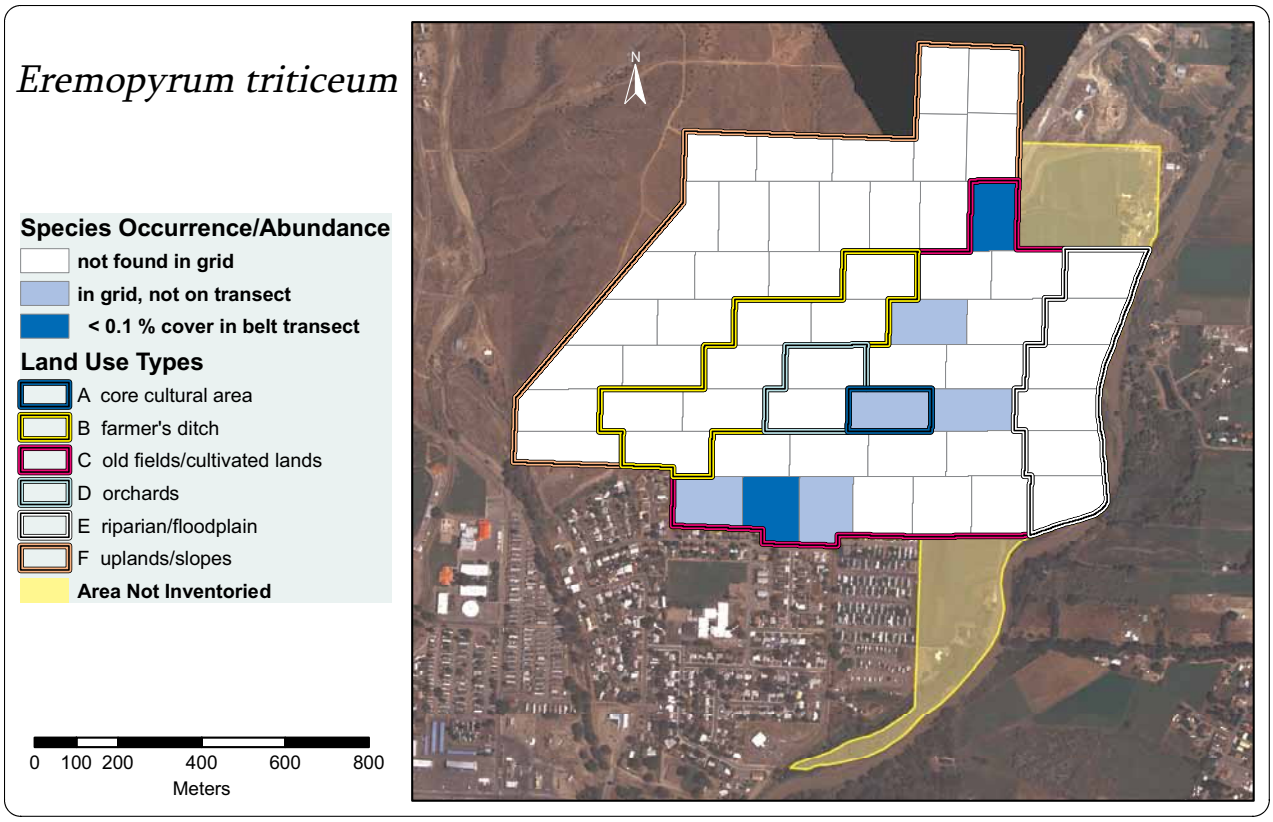

Figure E24. Species occurrence of *Eremopyrum triticeum* by grid cell.

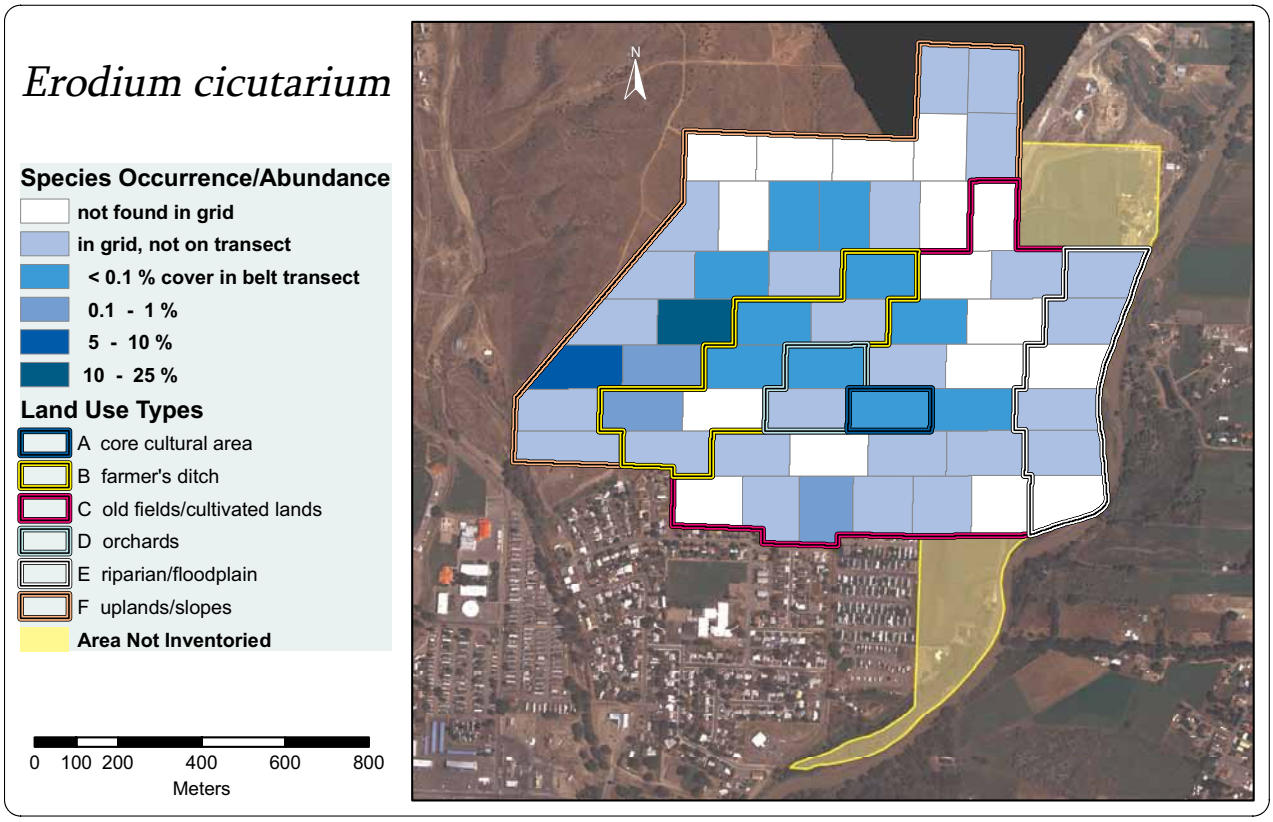

Figure E25. Species occurrence of *Erodium cicutarium* by grid cell.

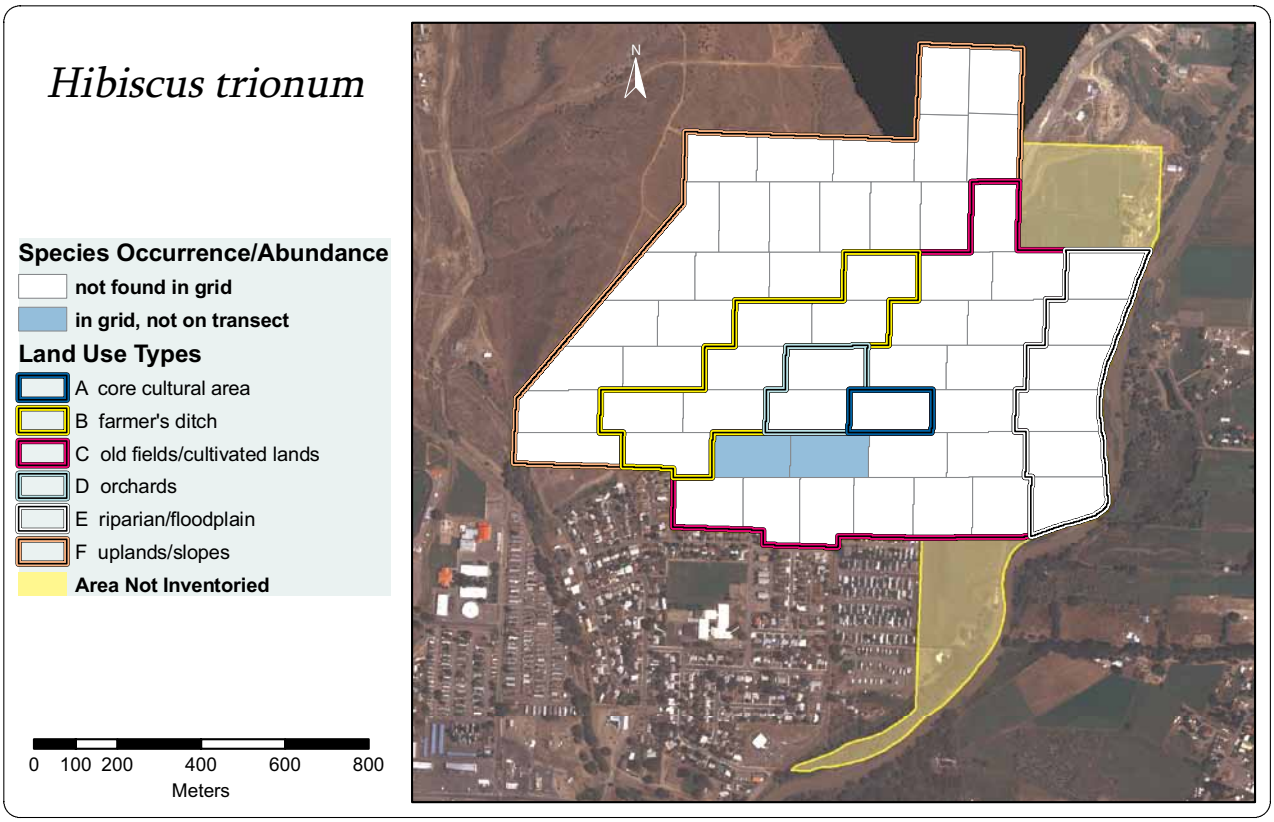

Figure E26. Species occurrence of *Hibiscus trionum* by grid cell.

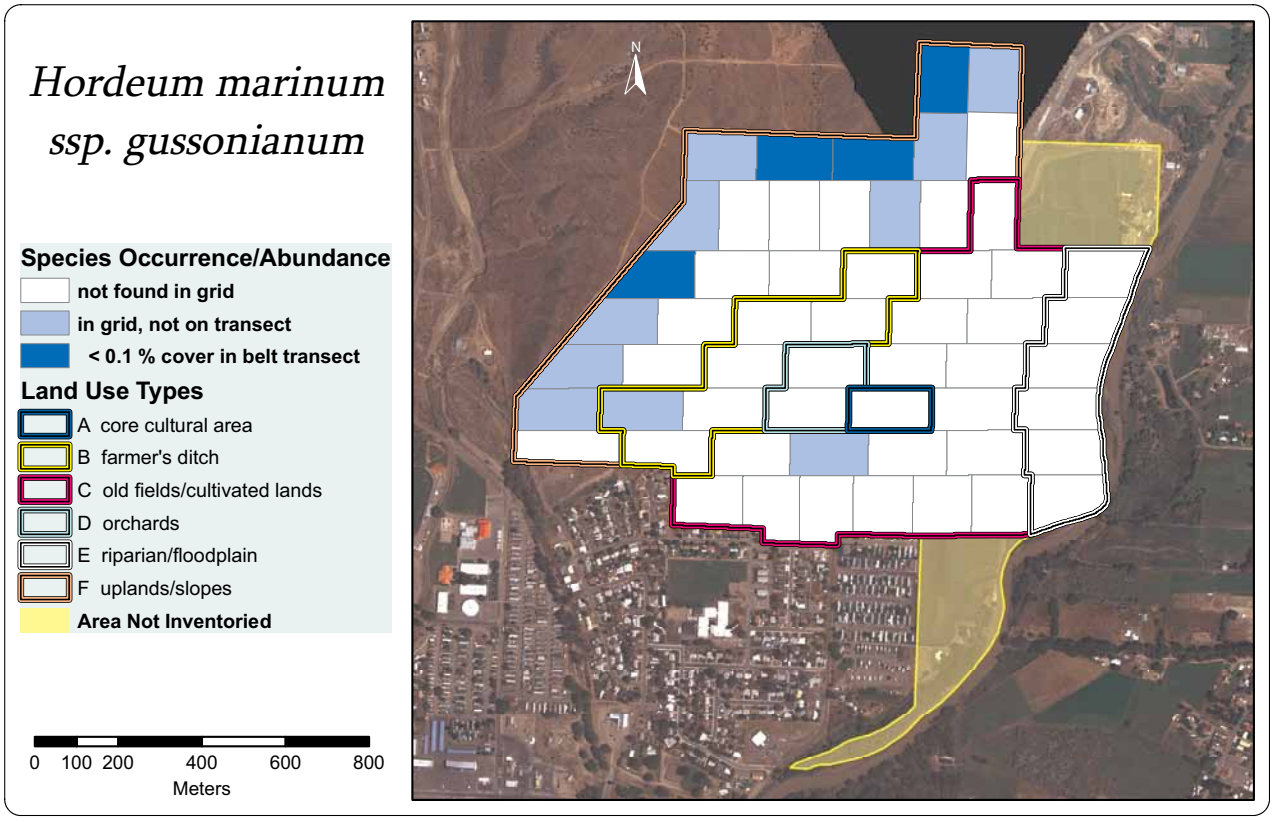

Figure E27. Species occurrence of *Hordeum marinum* ssp. *gussonianum* by grid cell.

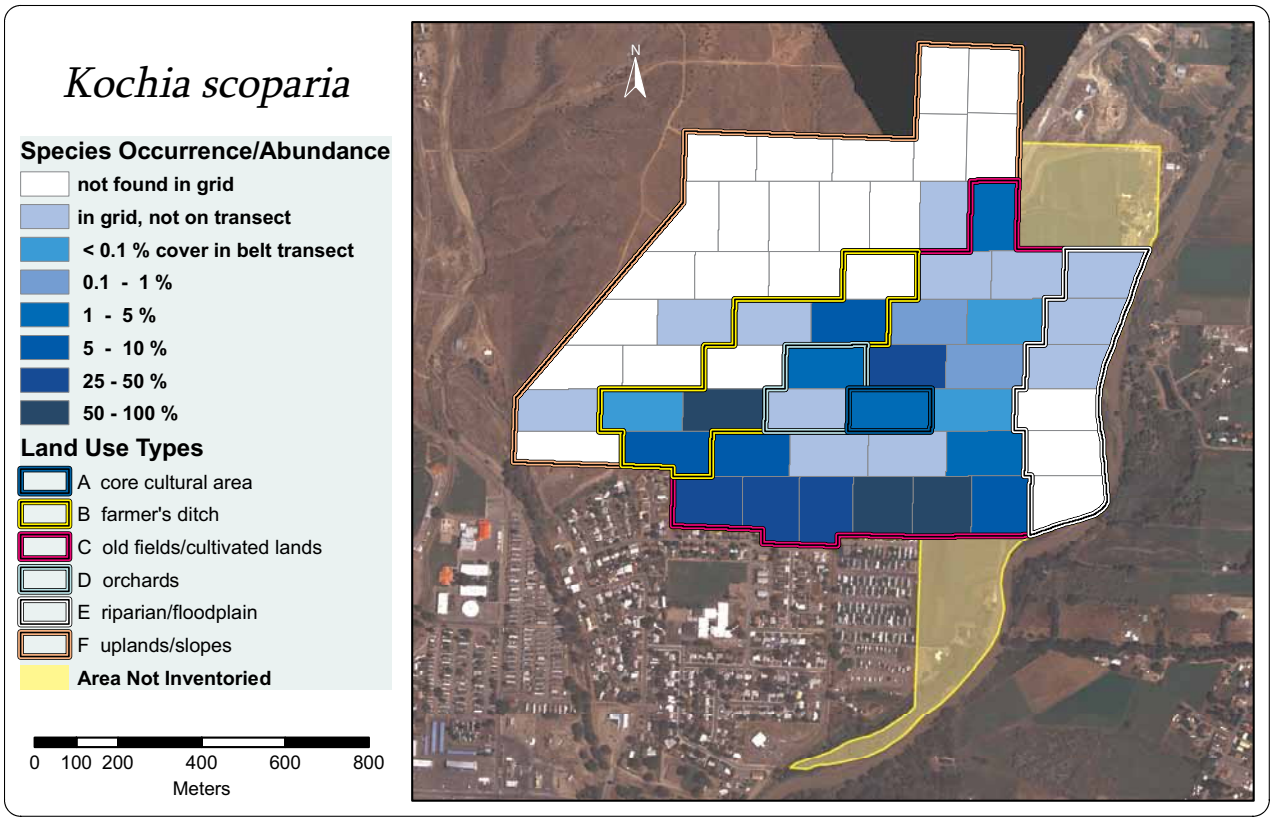

Figure E28. Species occurrence of *Kochia scoparia* by grid cell.

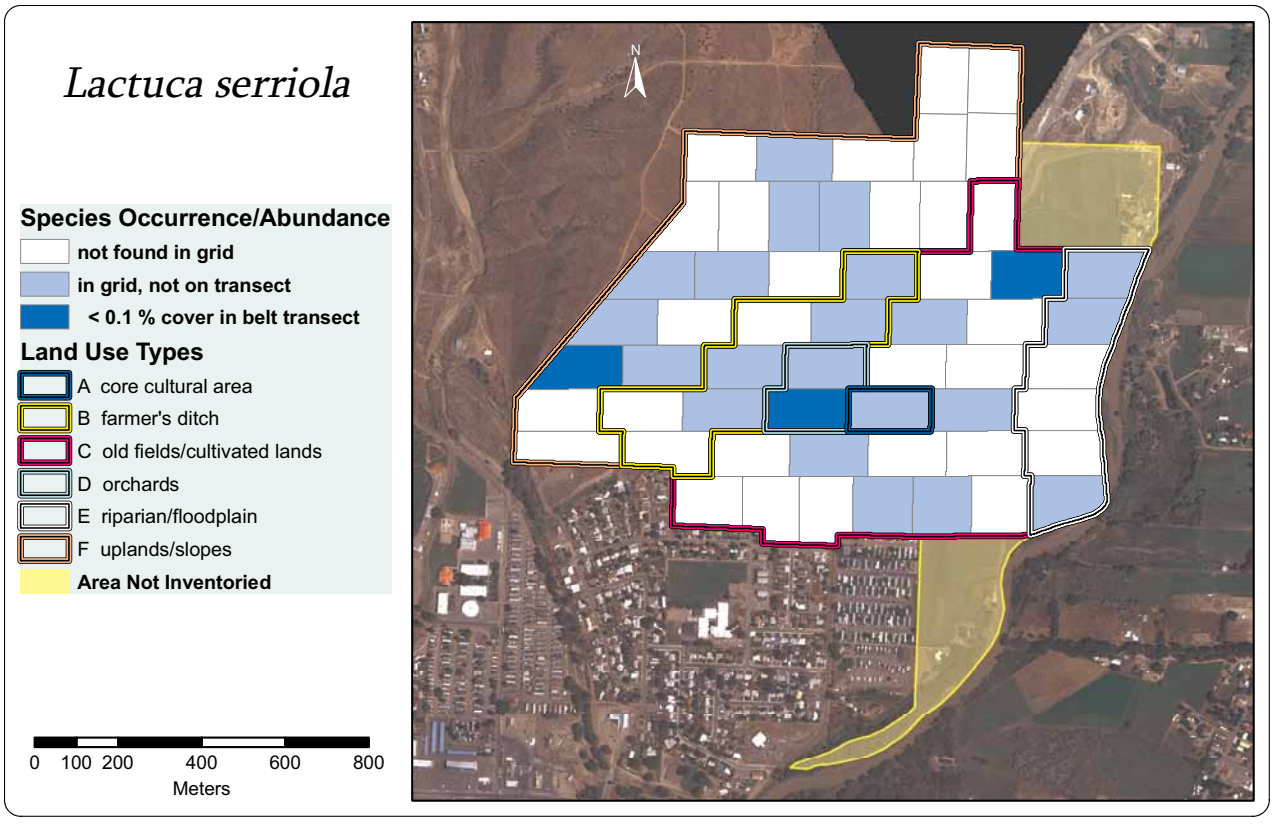

Figure E29. Species occurrence of *Lactuca serriola* by grid cell.

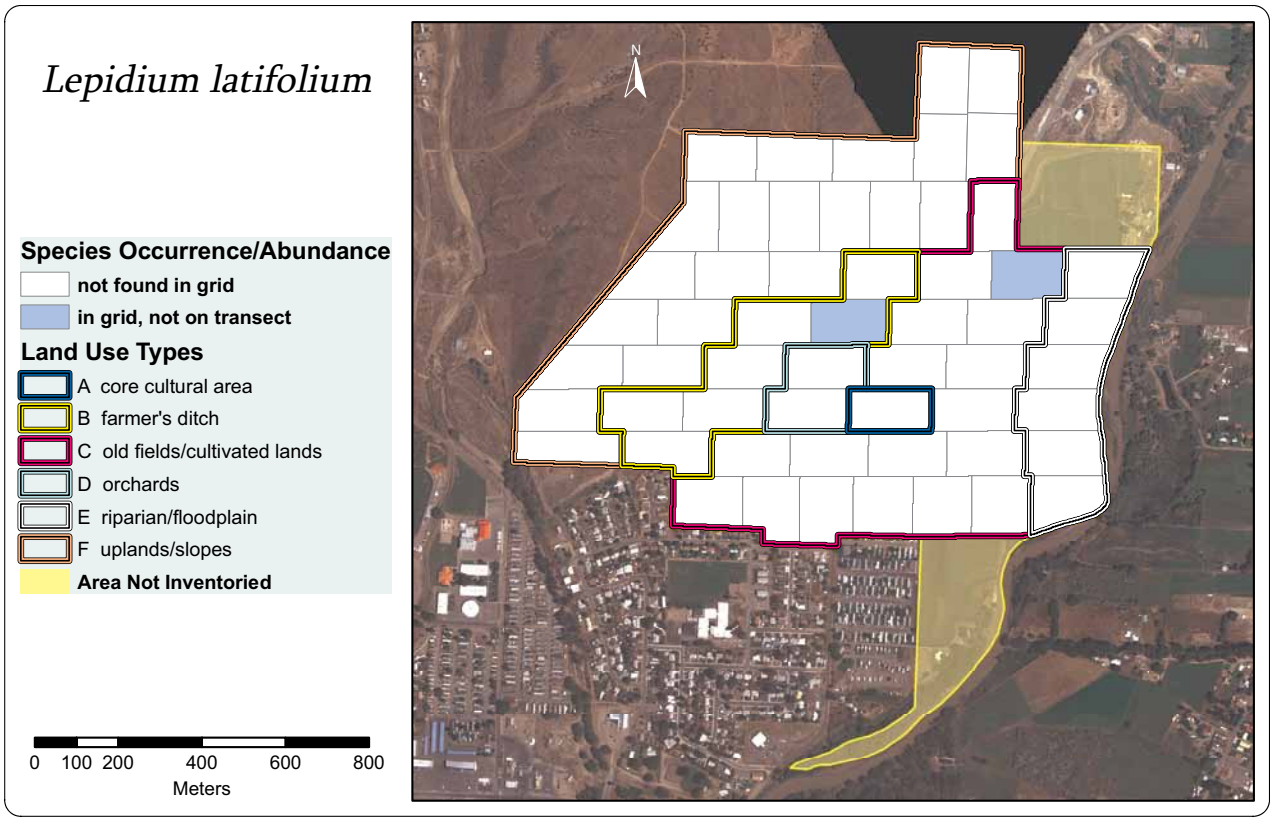

Figure E30. Species occurrence of *Lepidium latifolium* by grid cell.

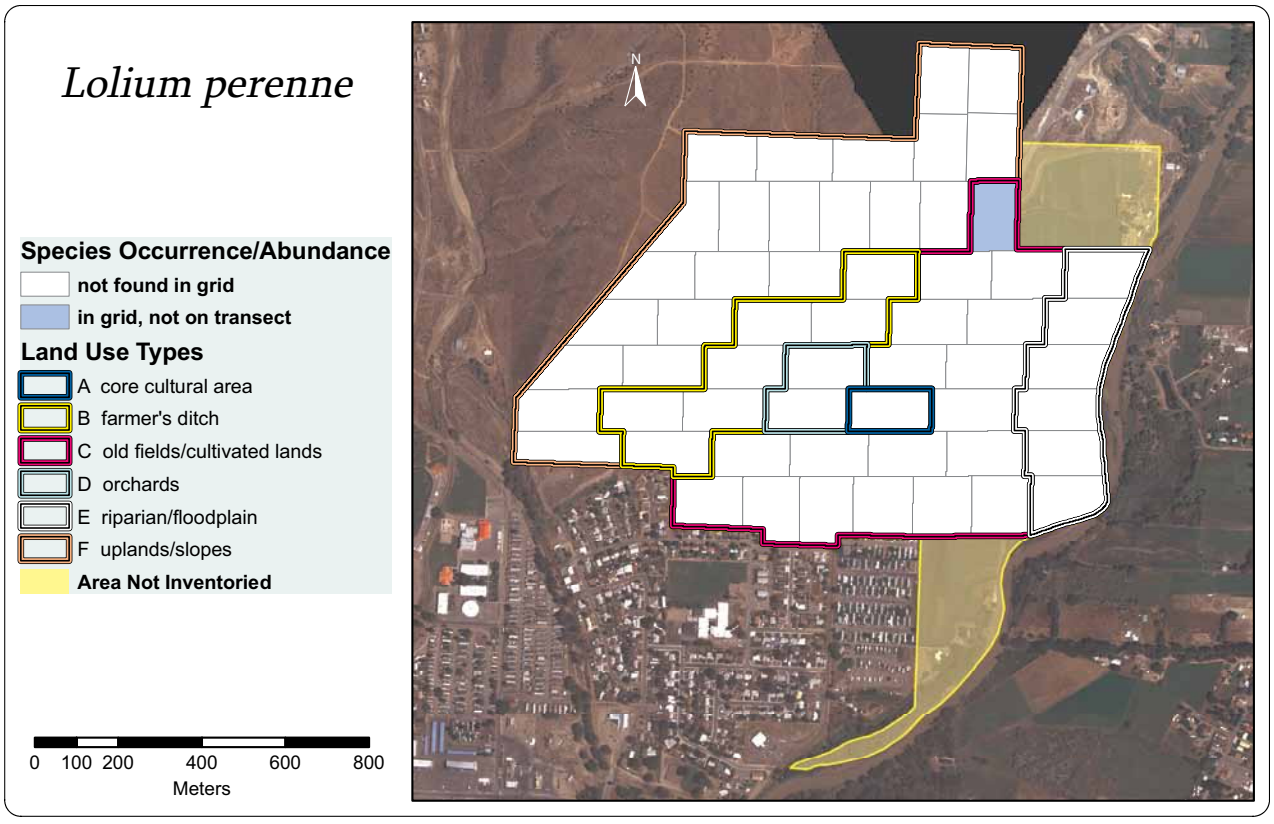

Figure E31. Species occurrence of *Lolium perenne* by grid cell.

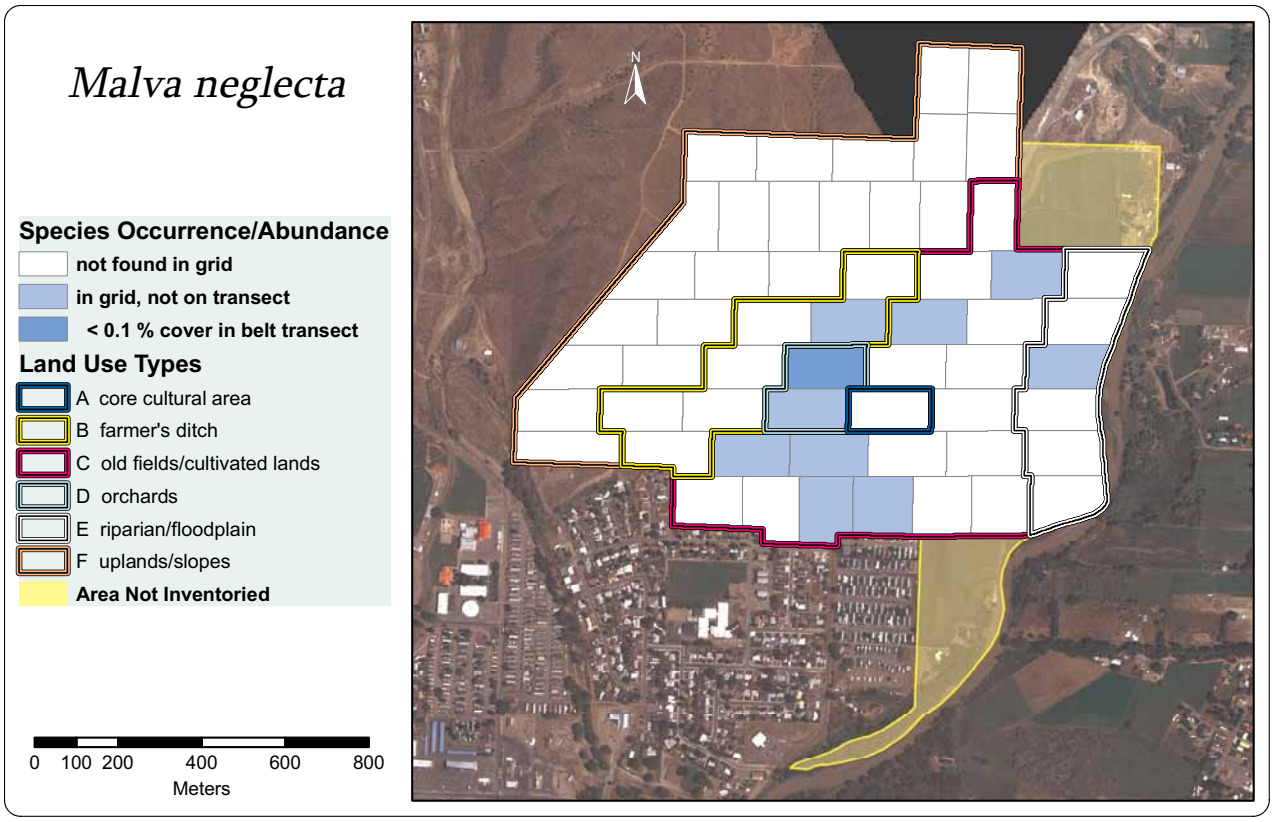

Figure E32. Species occurrence of *Malva neglecta* by grid cell.

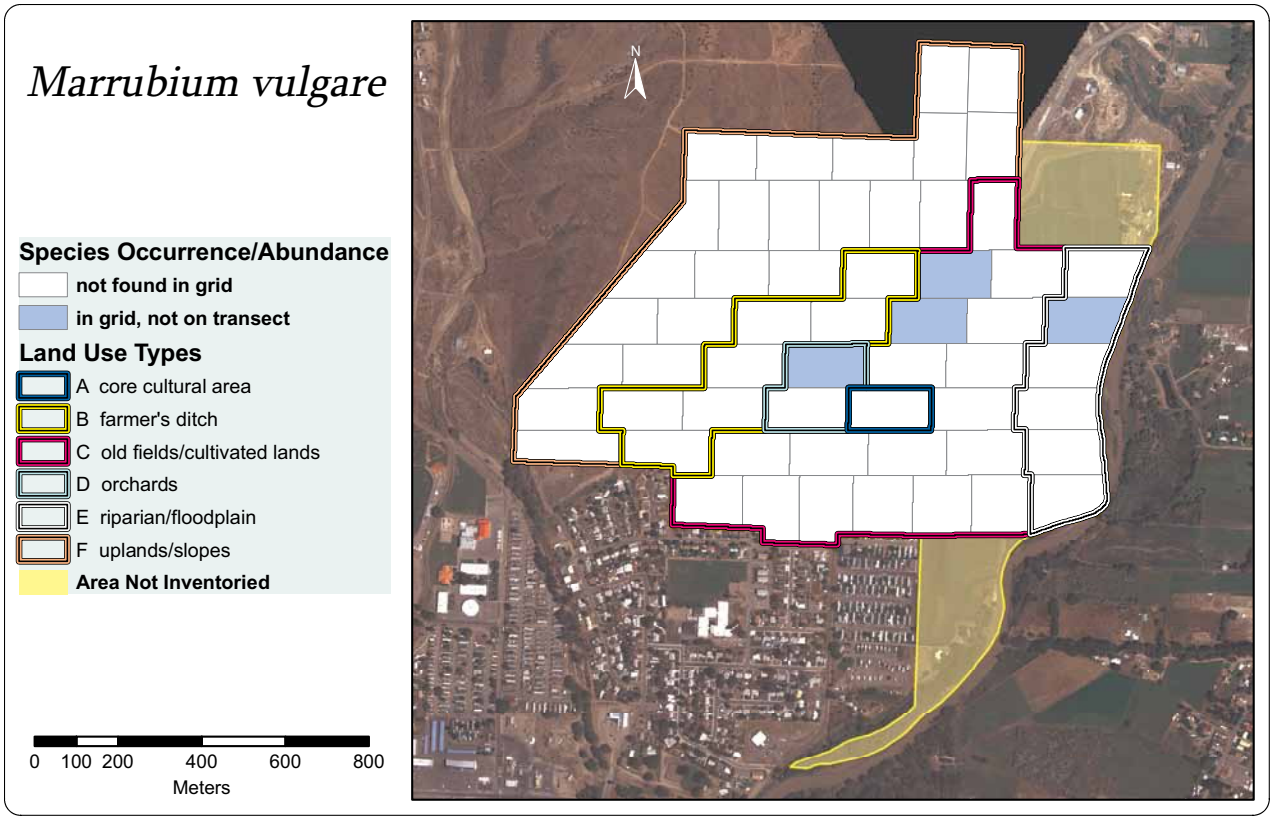

Figure E33. Species occurrence of *Marrubium vulgare* by grid cell.

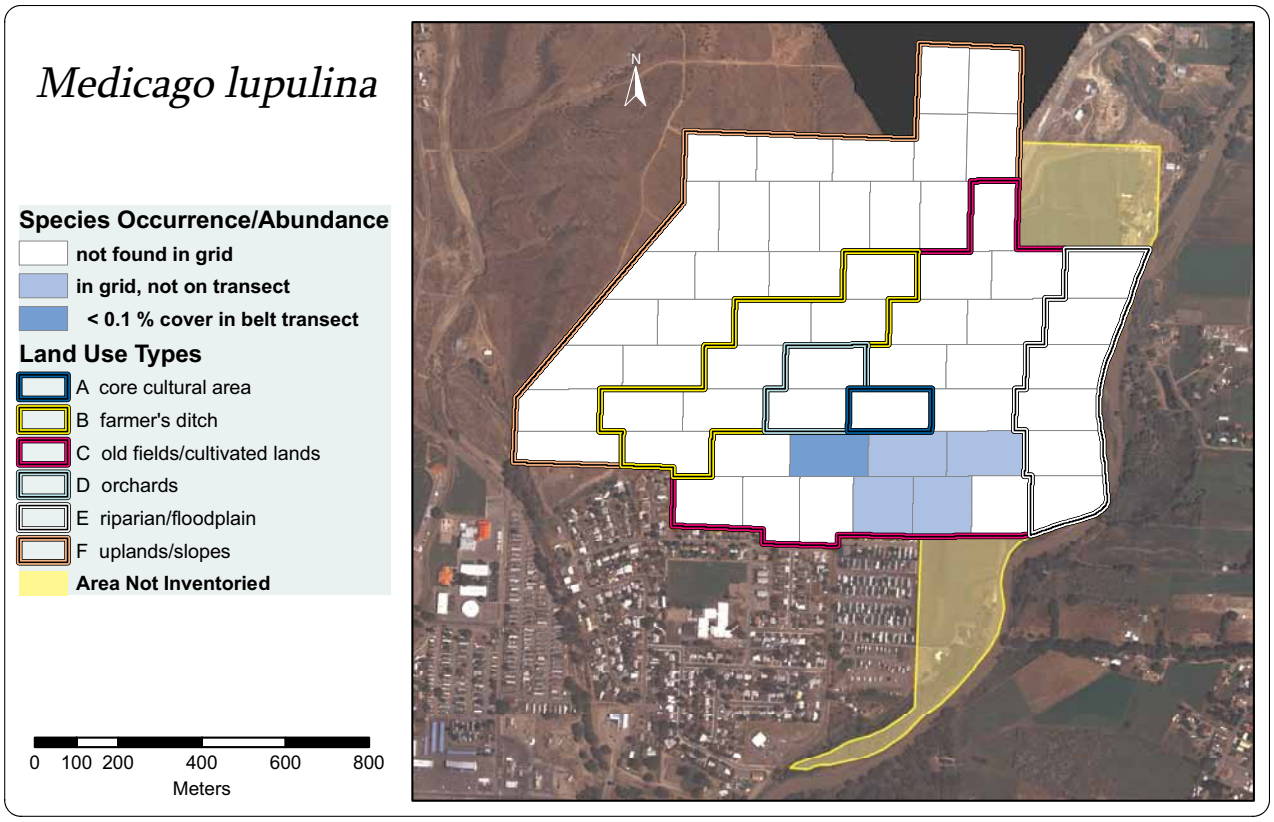

Figure E34. Species occurrence of *Medicago lupulina* by grid cell.

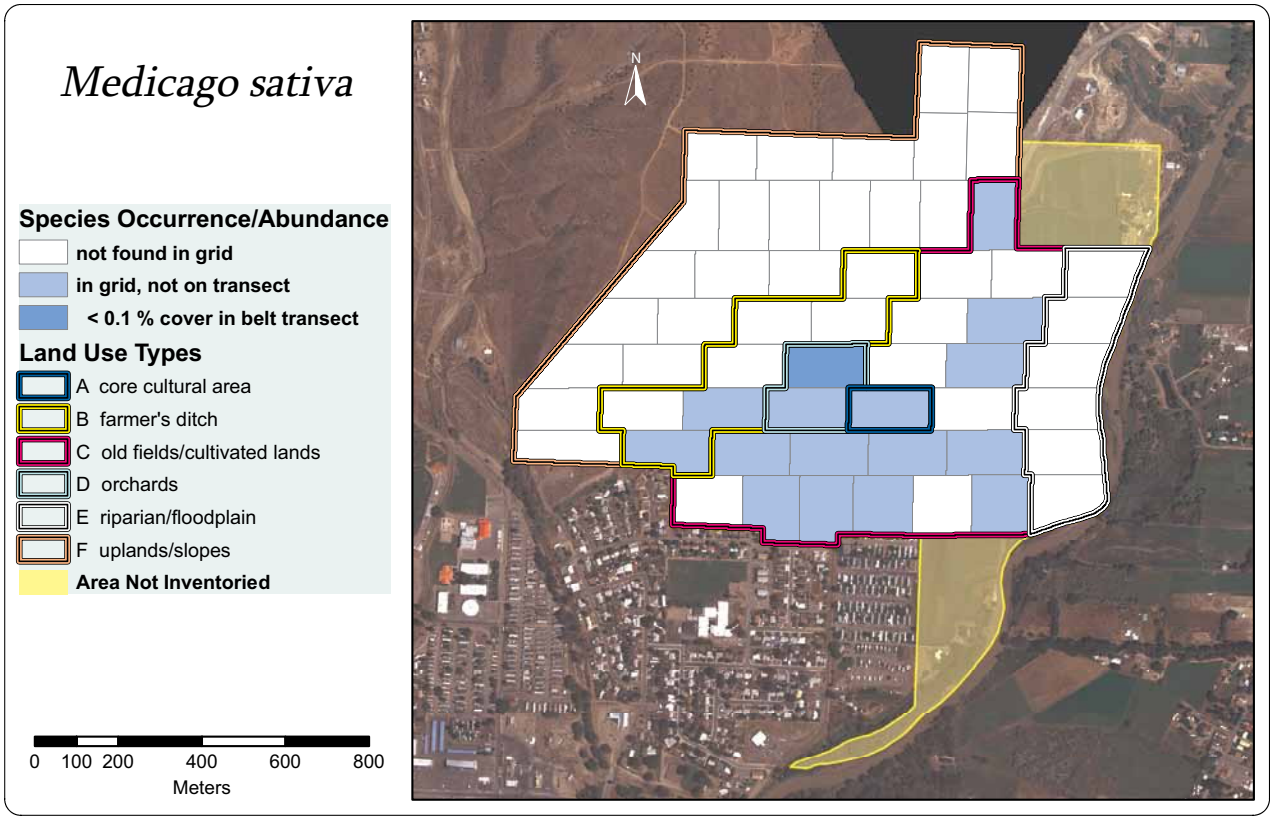

Figure E35. Species occurrence of *Medicago sativa* by grid cell.

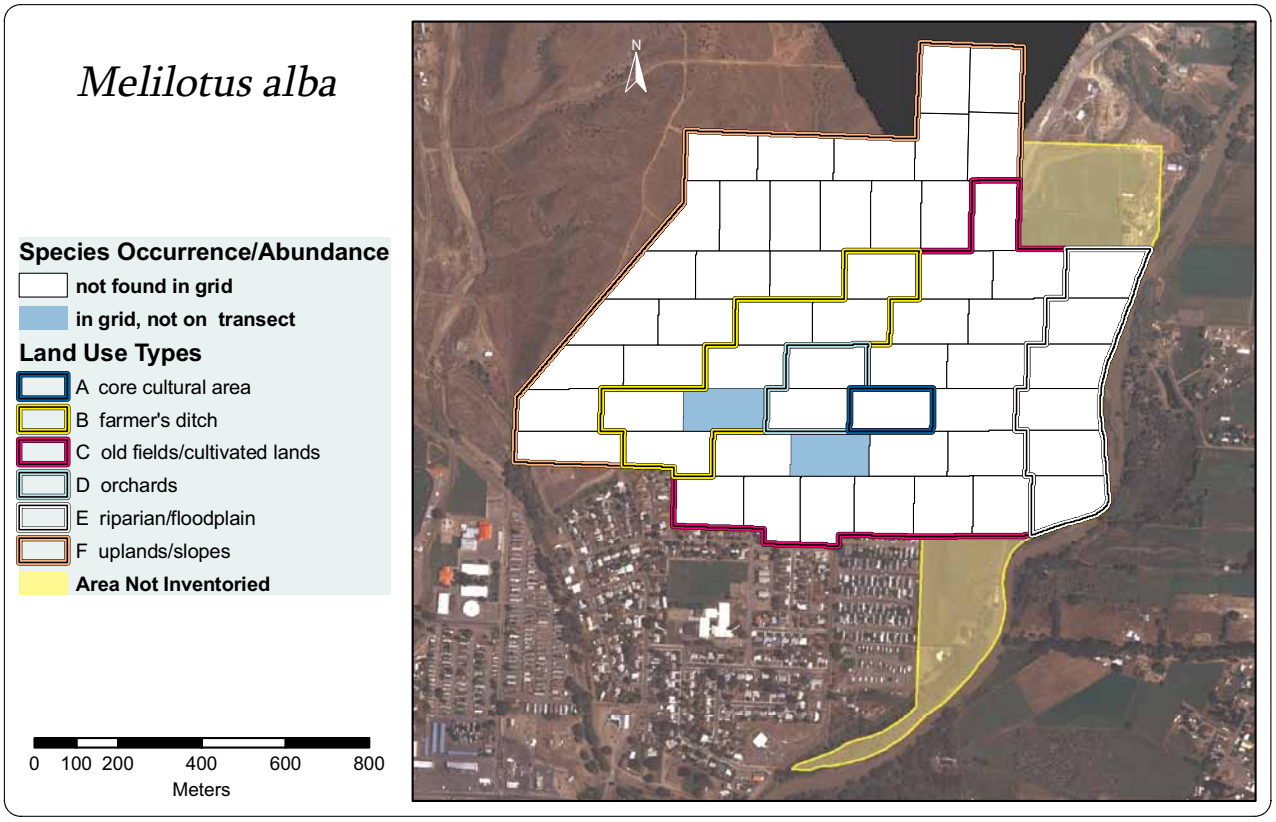

Figure E36. Species occurrence of *Melilotus alba* by grid cell.

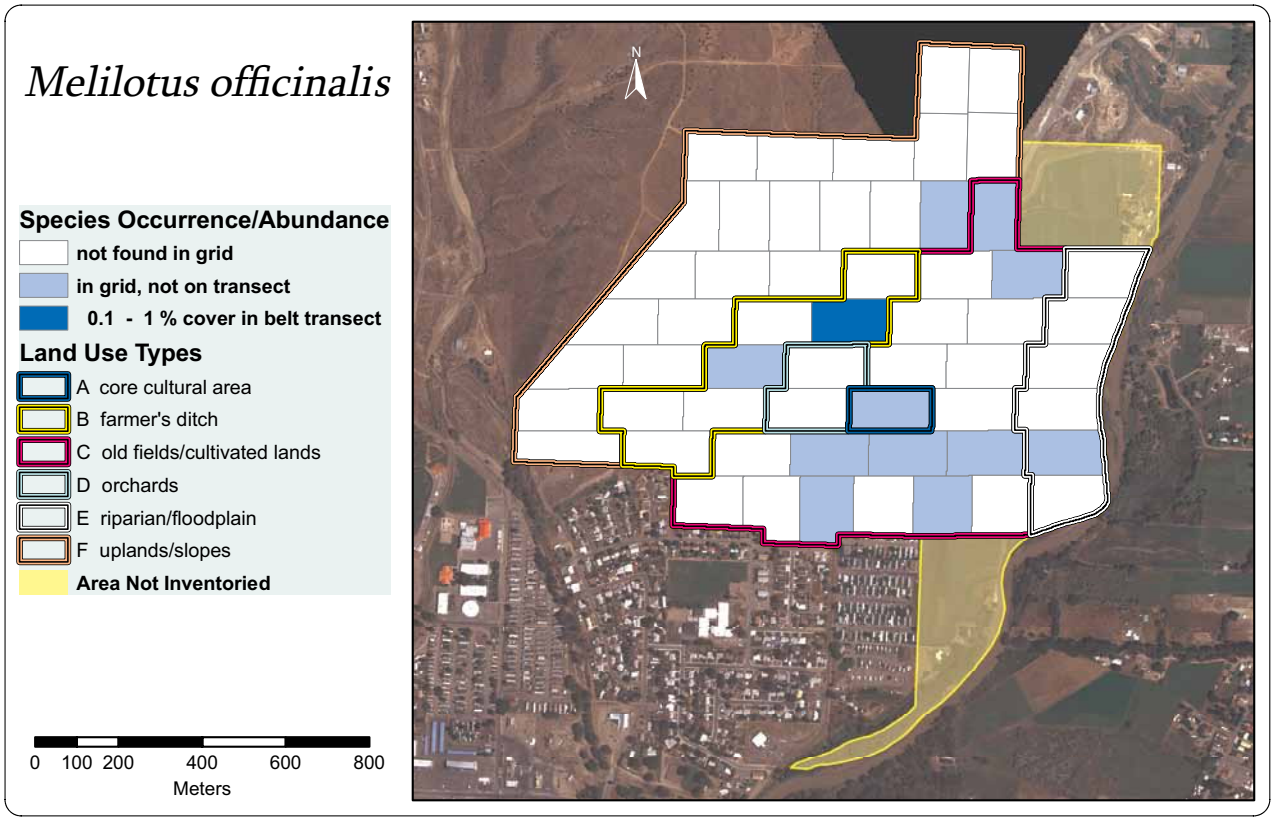

Figure E37. Species occurrence of *Melilotus officinalis* by grid cell.

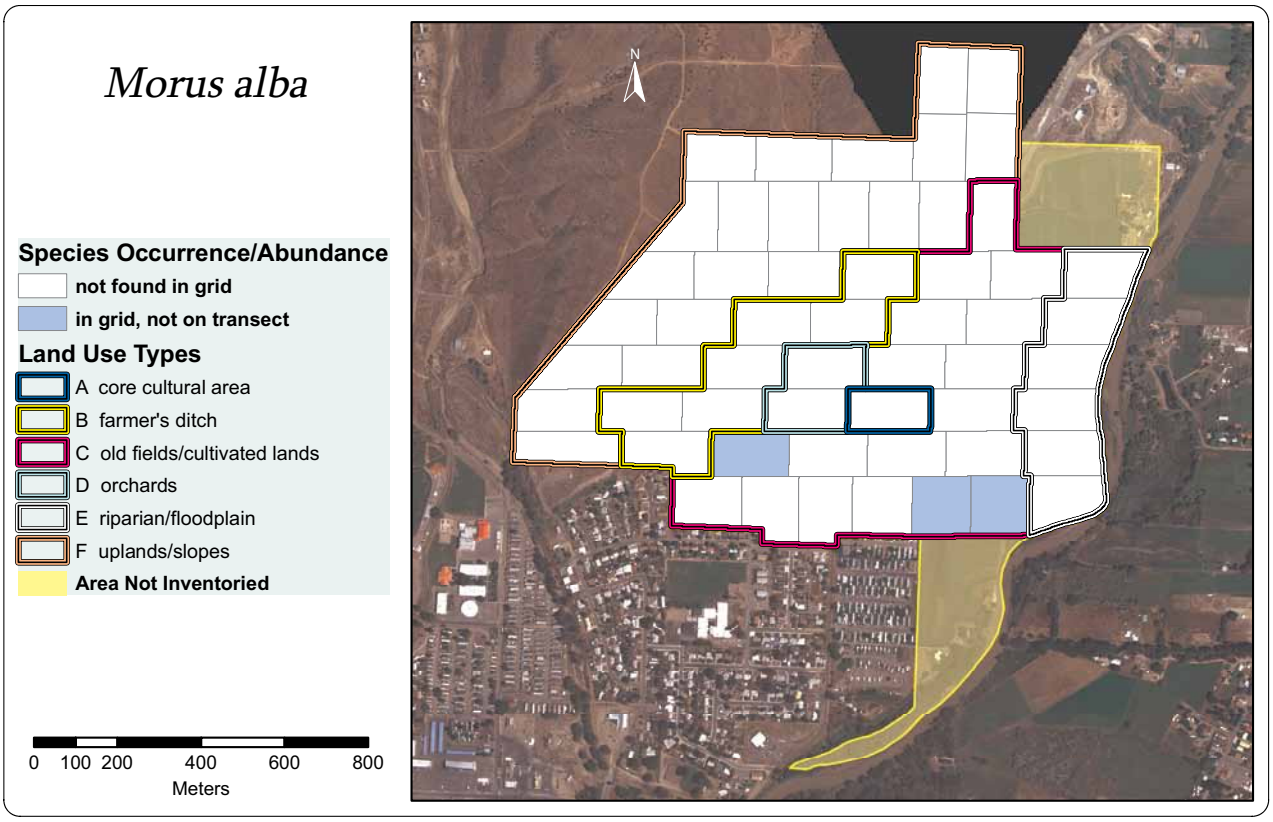

Figure E38. Species occurrence of *Morus alba* by grid cell.

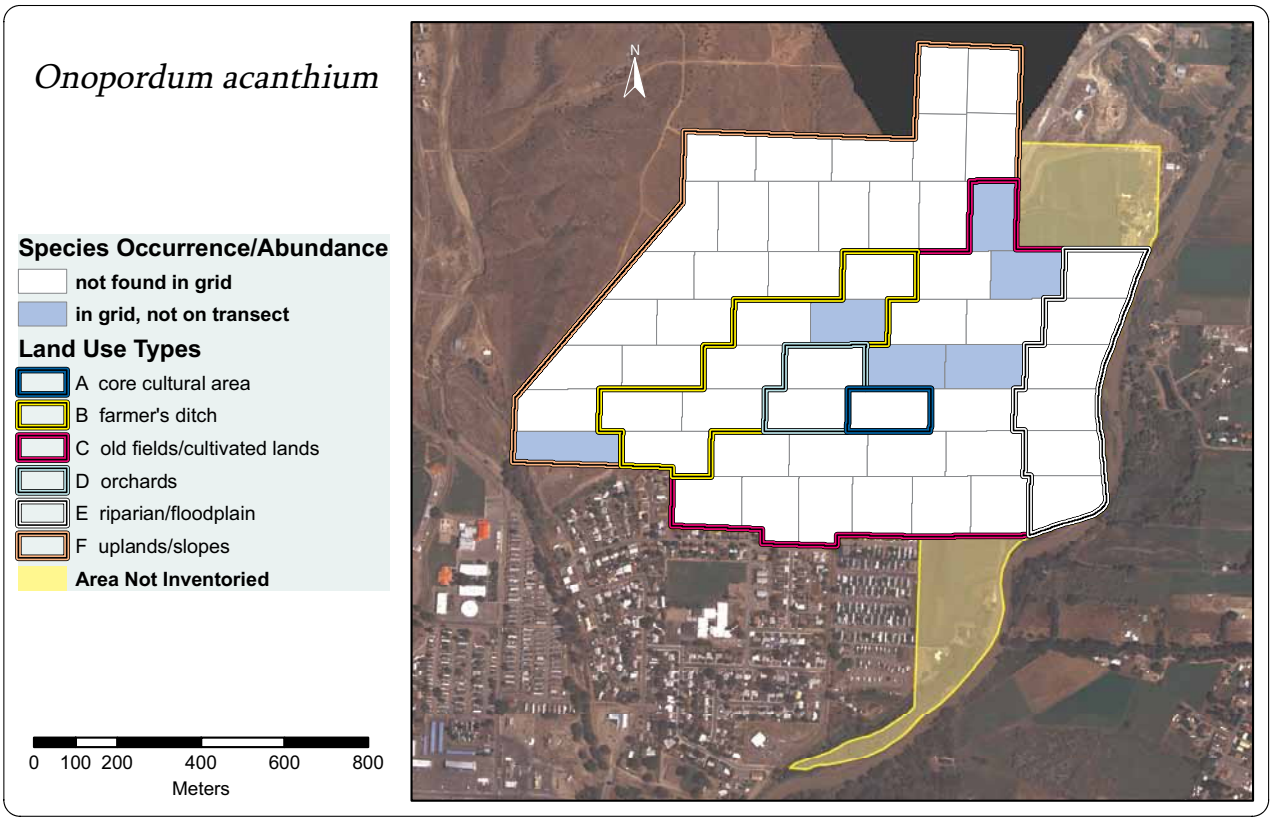

Figure E39. Species occurrence of *Onopordum acanthium* by grid cell.

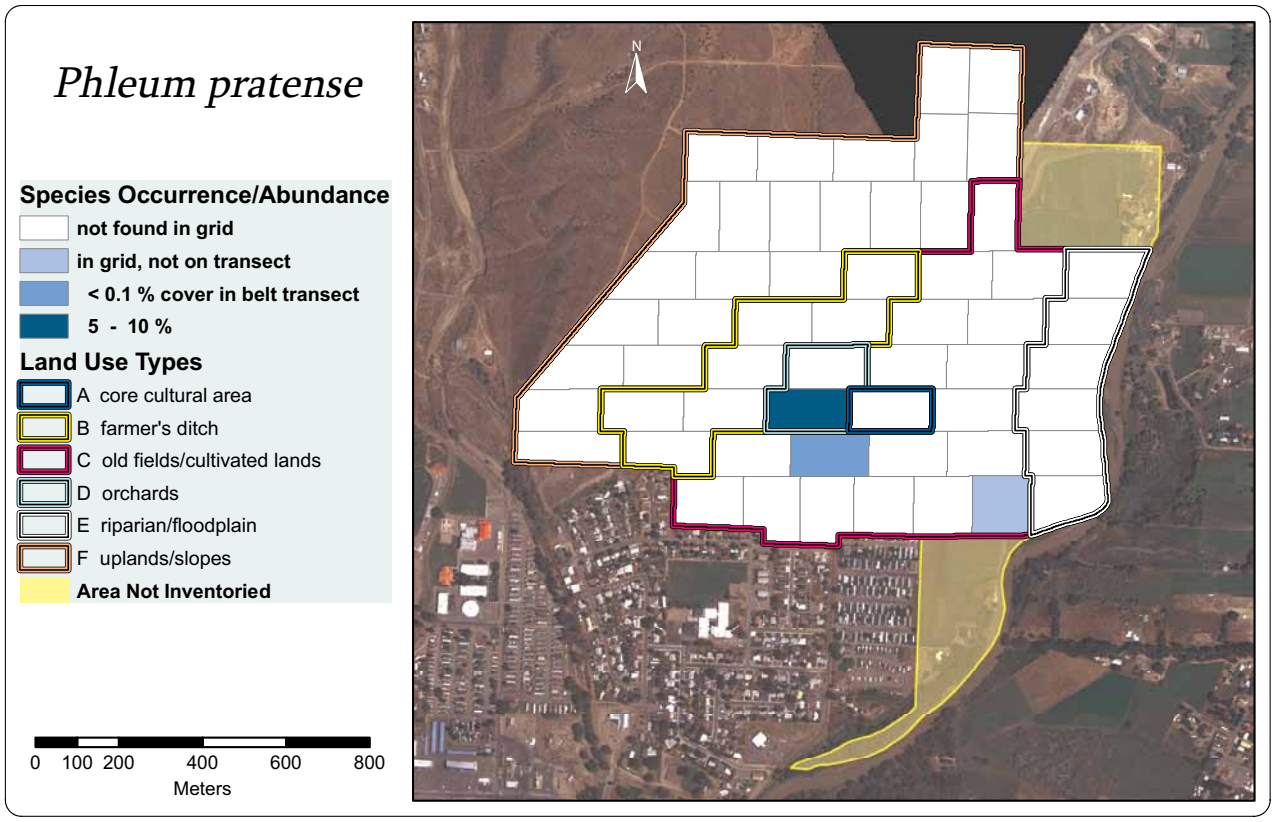

Figure E40. Species occurrence of *Phleum pratense* by grid cell.

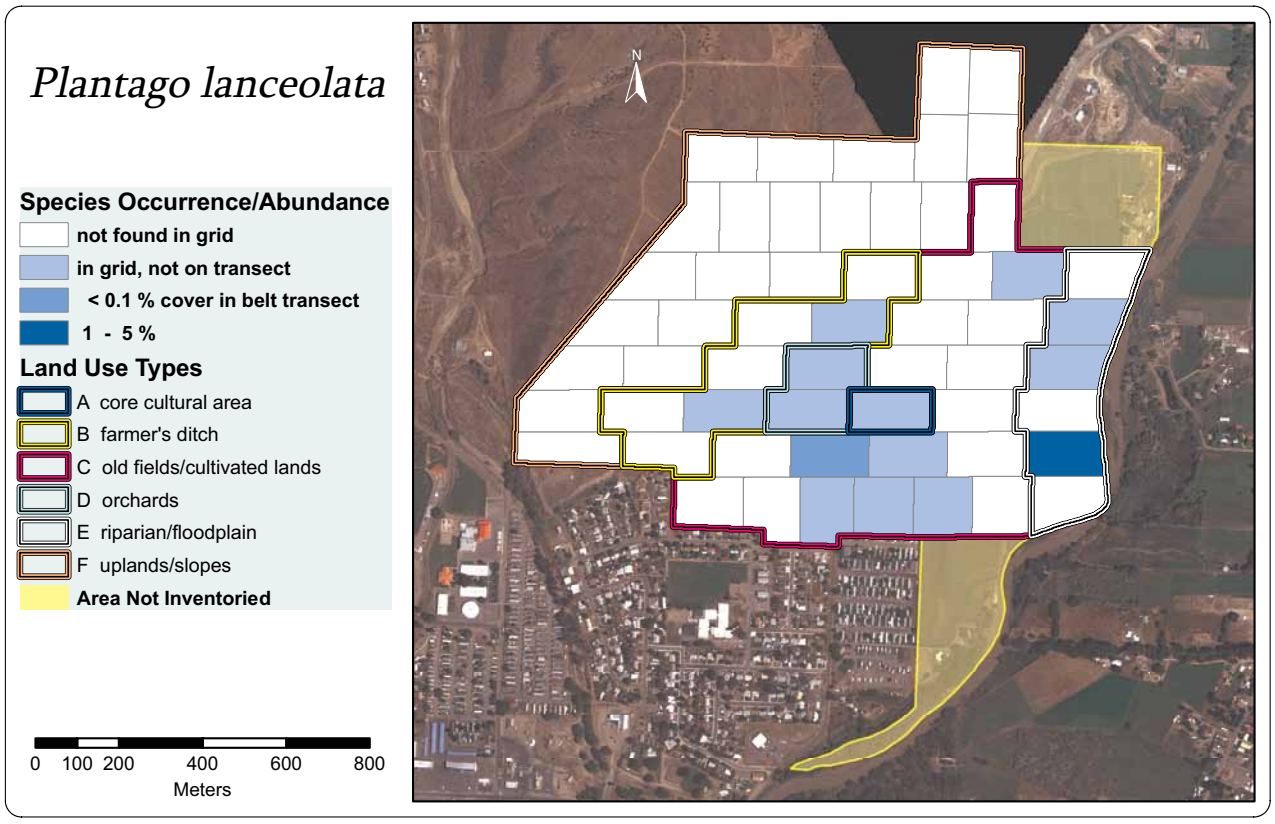

Figure E41. Species occurrence of *Plantago lanceolata* by grid cell.

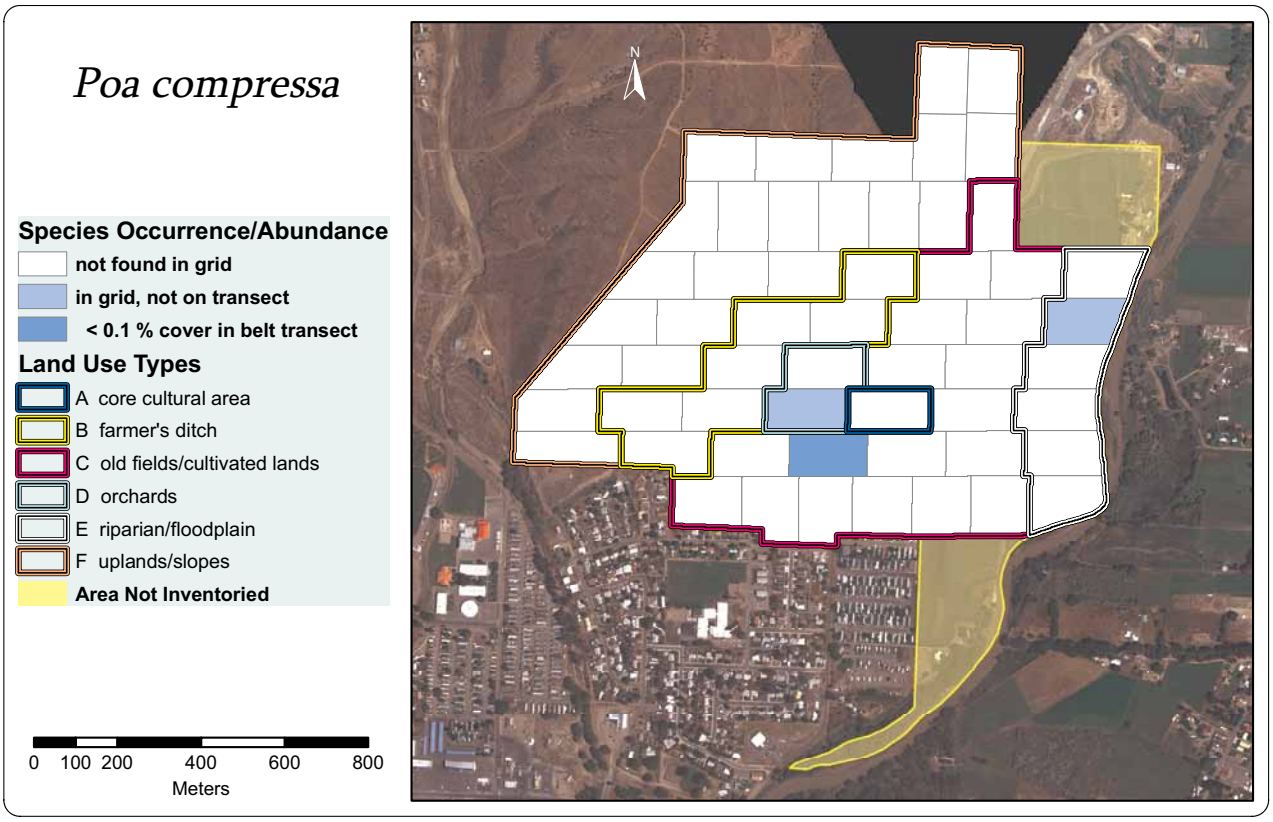

Figure E42. Species occurrence of *Poa compressa* by grid cell.

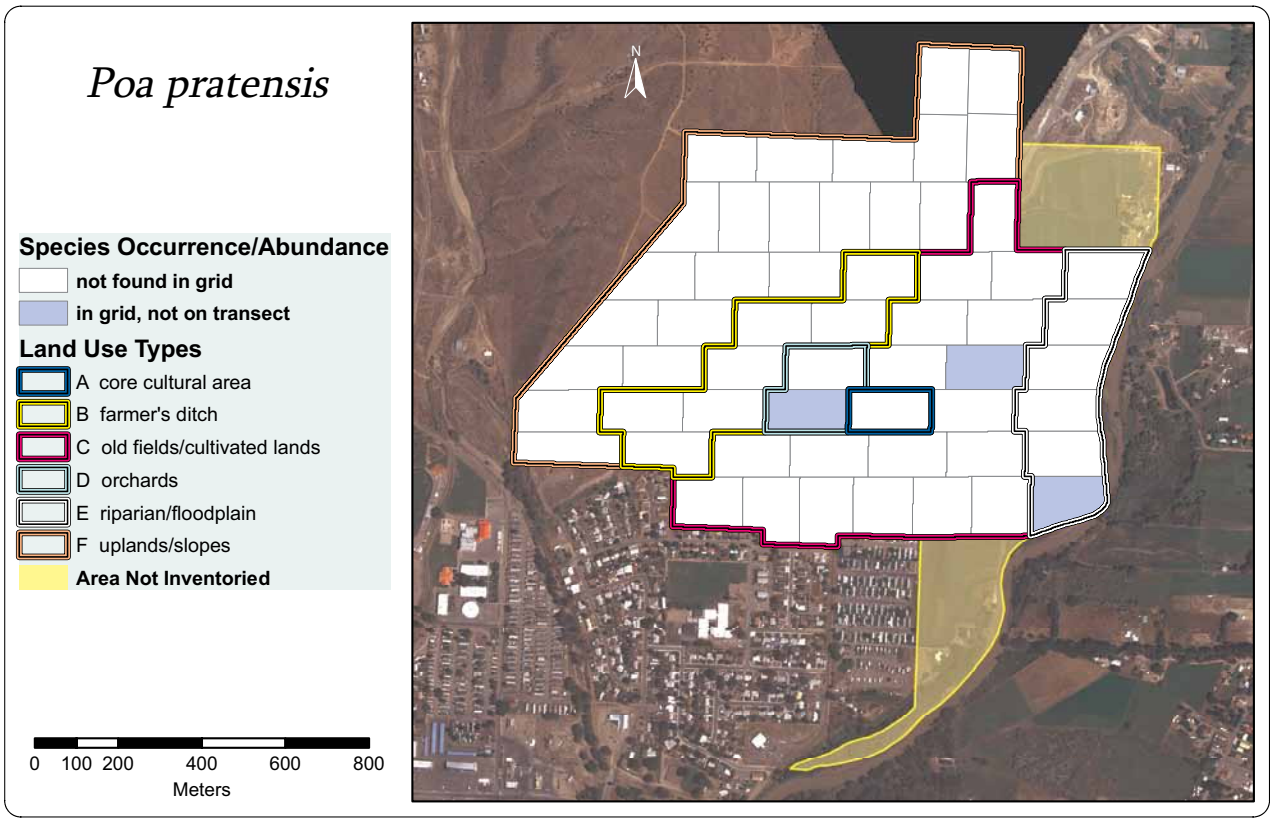

Figure E43. Species occurrence of *Poa pratensis* by grid cell.

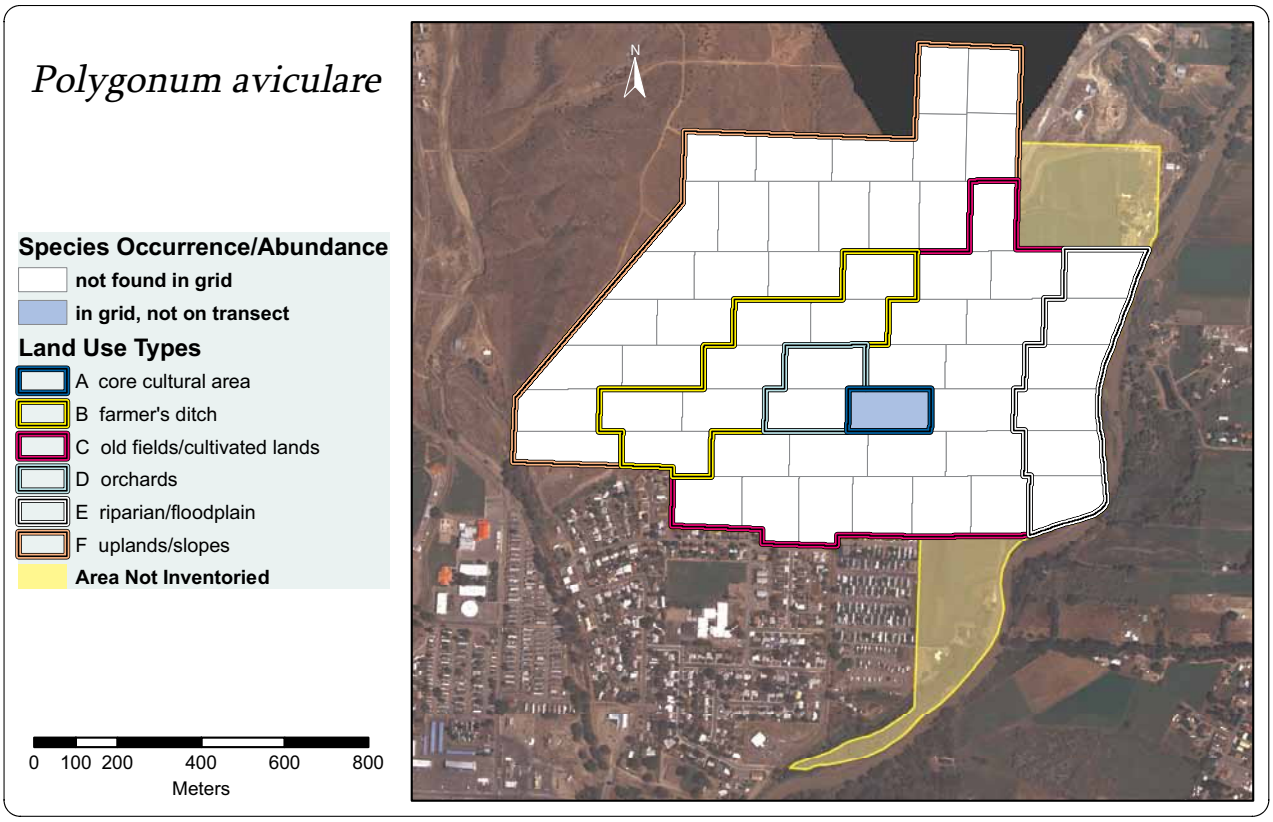

Figure E44. Species occurrence of *Polygonum aviculare* by grid cell.

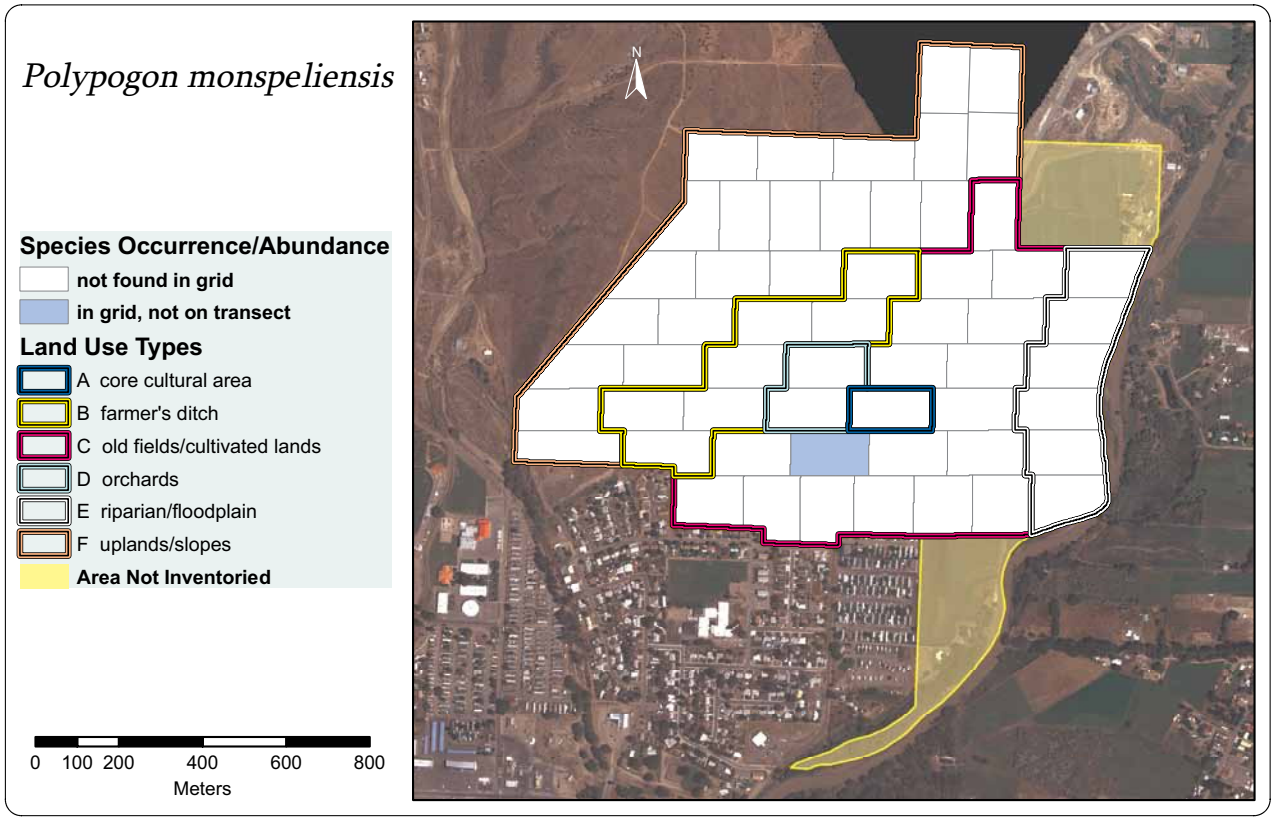

Figure E45. Species occurrence of *Polypogon monspeliensis* by grid cell.

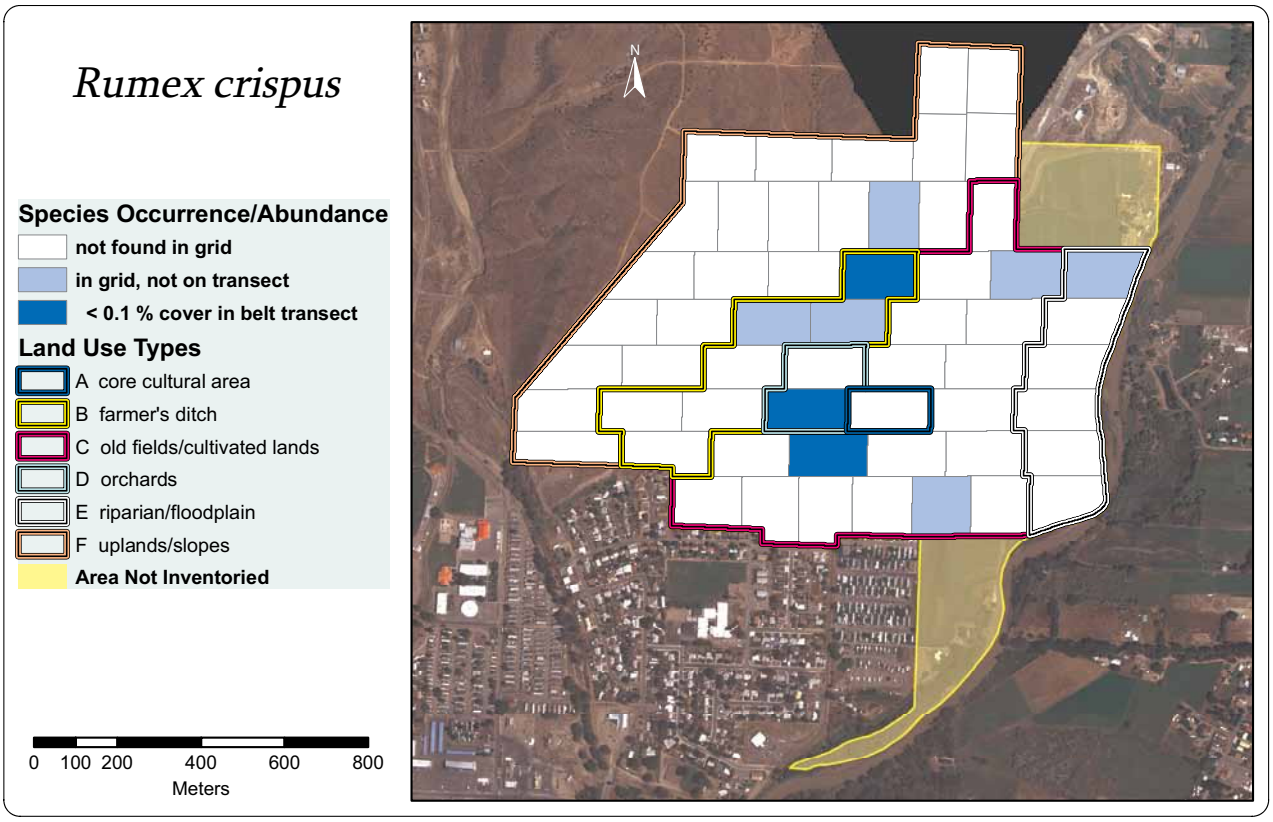

Figure E46. Species occurrence of *Rumex crispus* by grid cell.

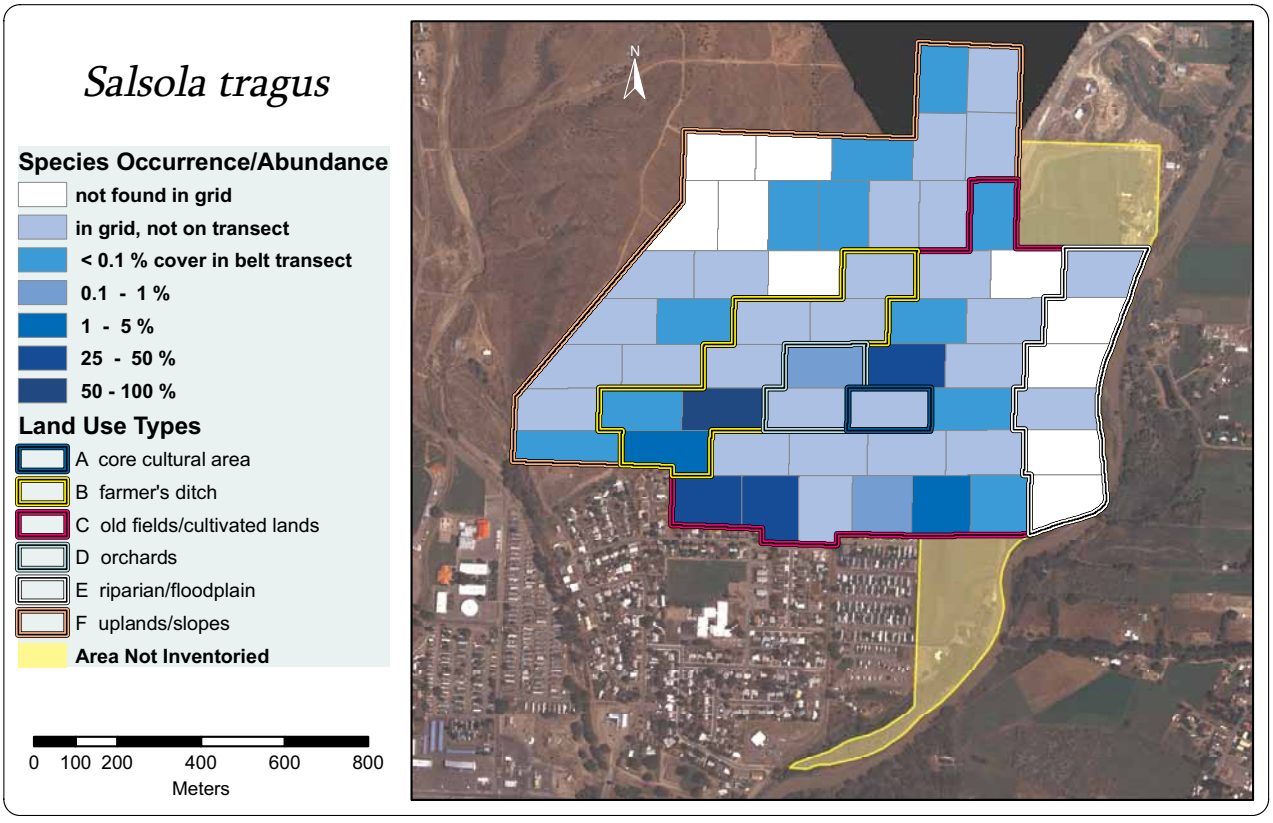

Figure E47. Species occurrence of *Salsola tragus* by grid cell.

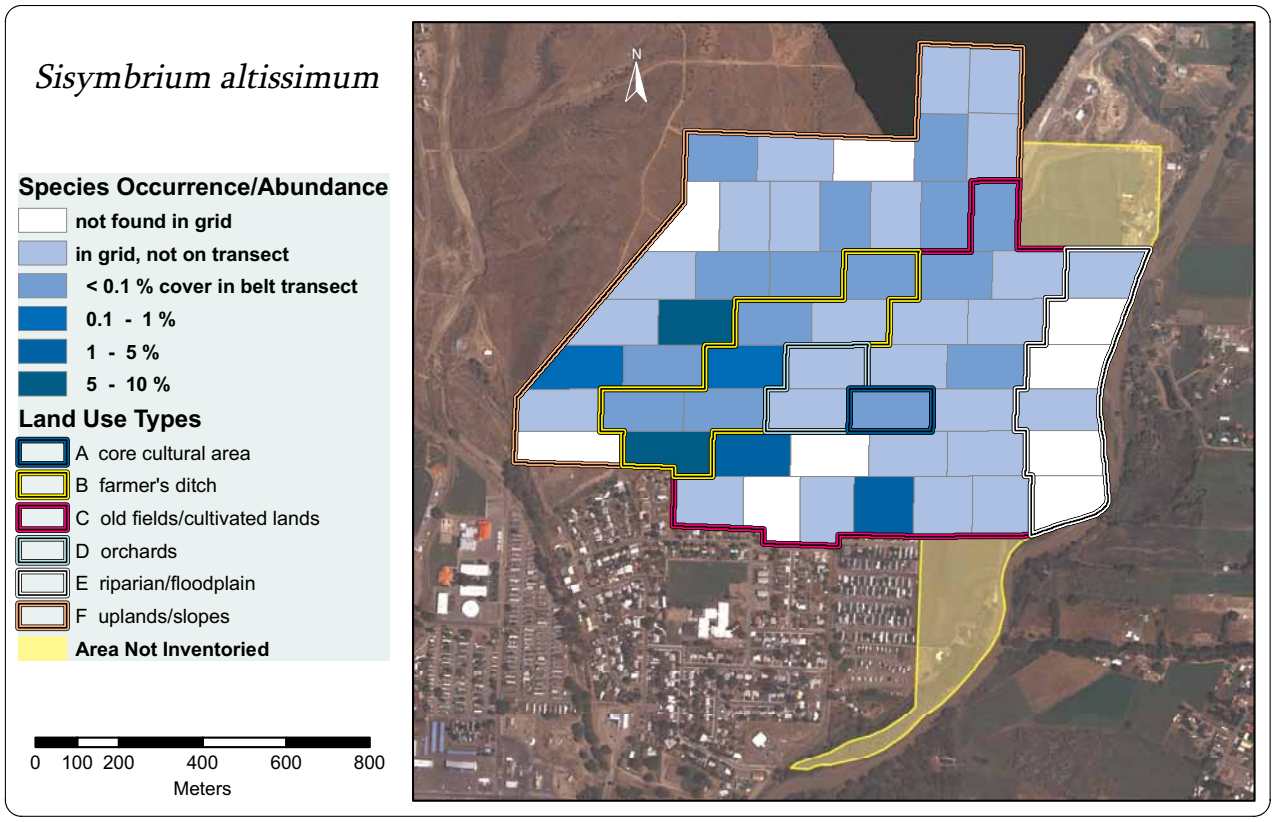

Figure E48. Species occurrence of *Sisymbrium altissimum* by grid cell.

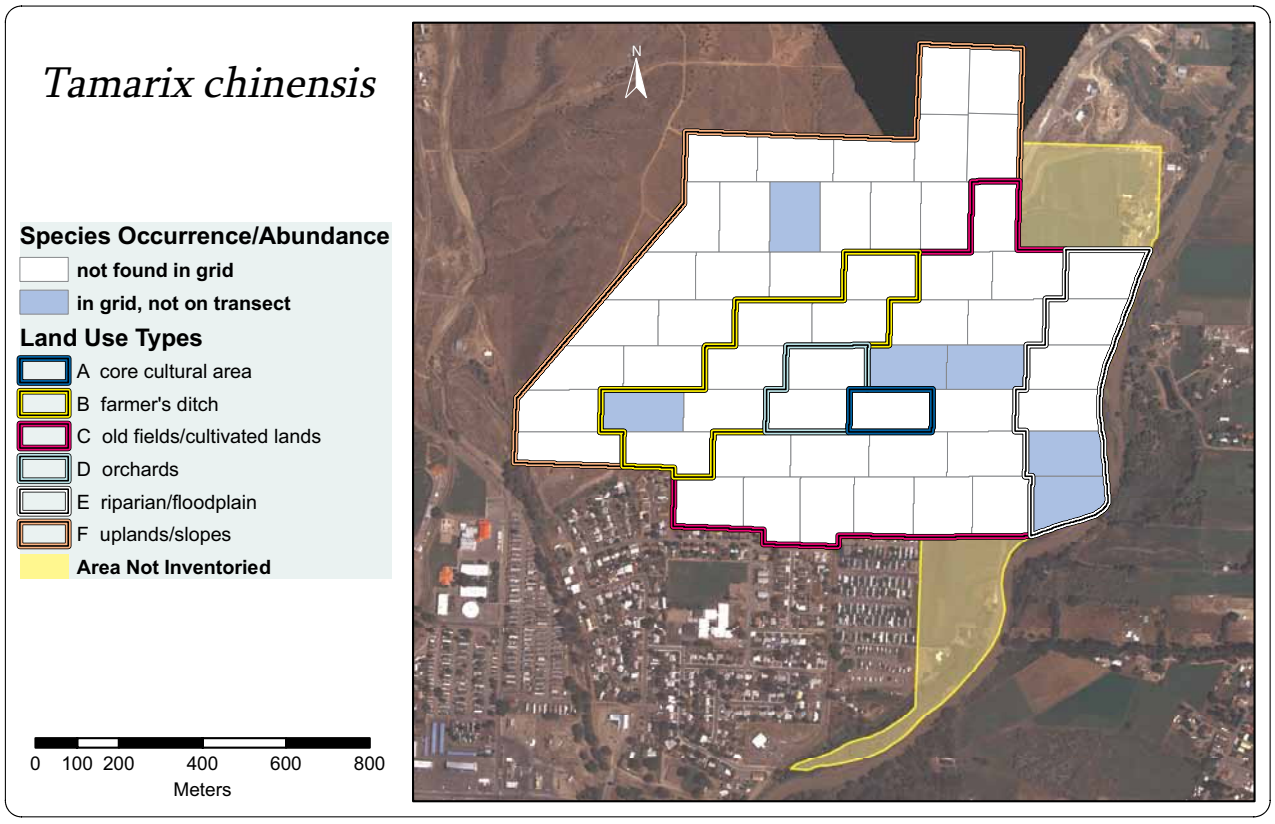

Figure E49. Species occurrence of *Tamarix chinensis* by grid cell.

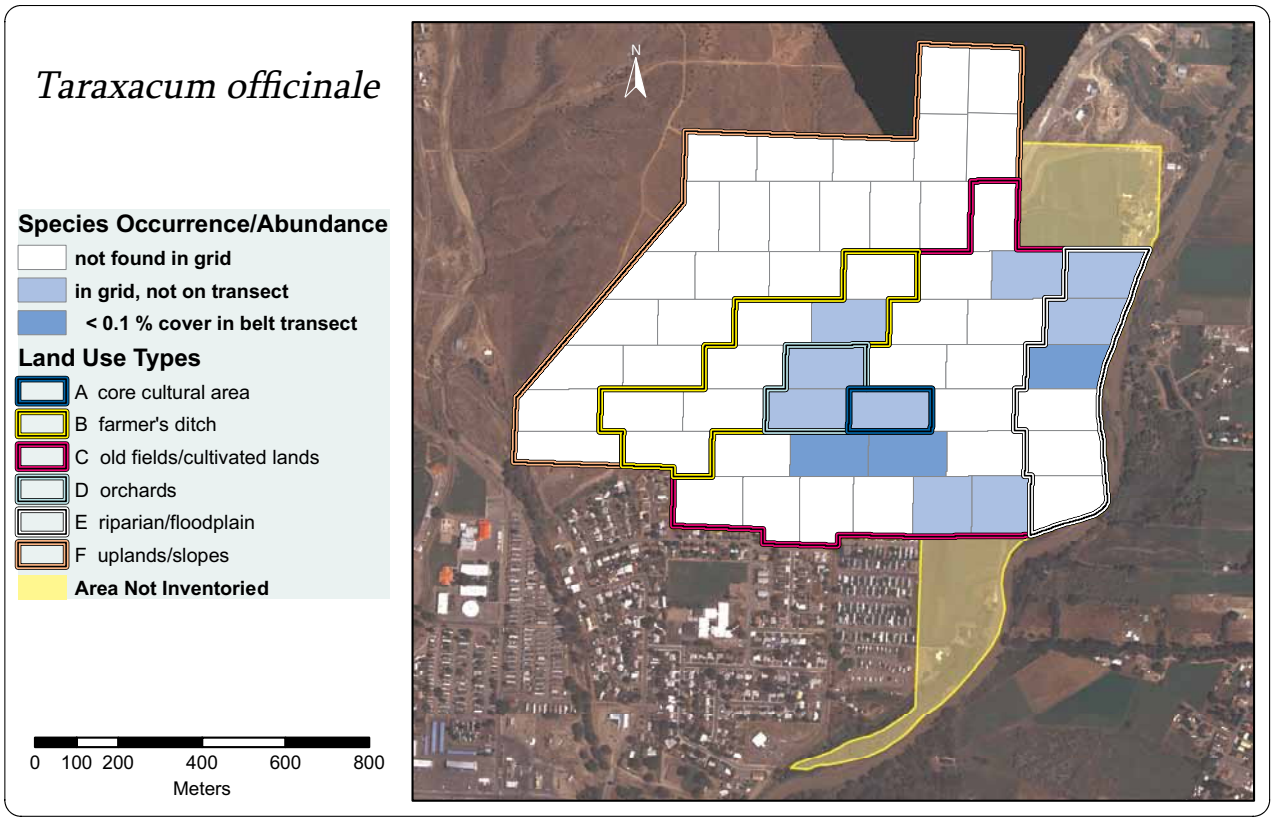

Figure E50. Species occurrence of *Taraxacum officinale* by grid cell.

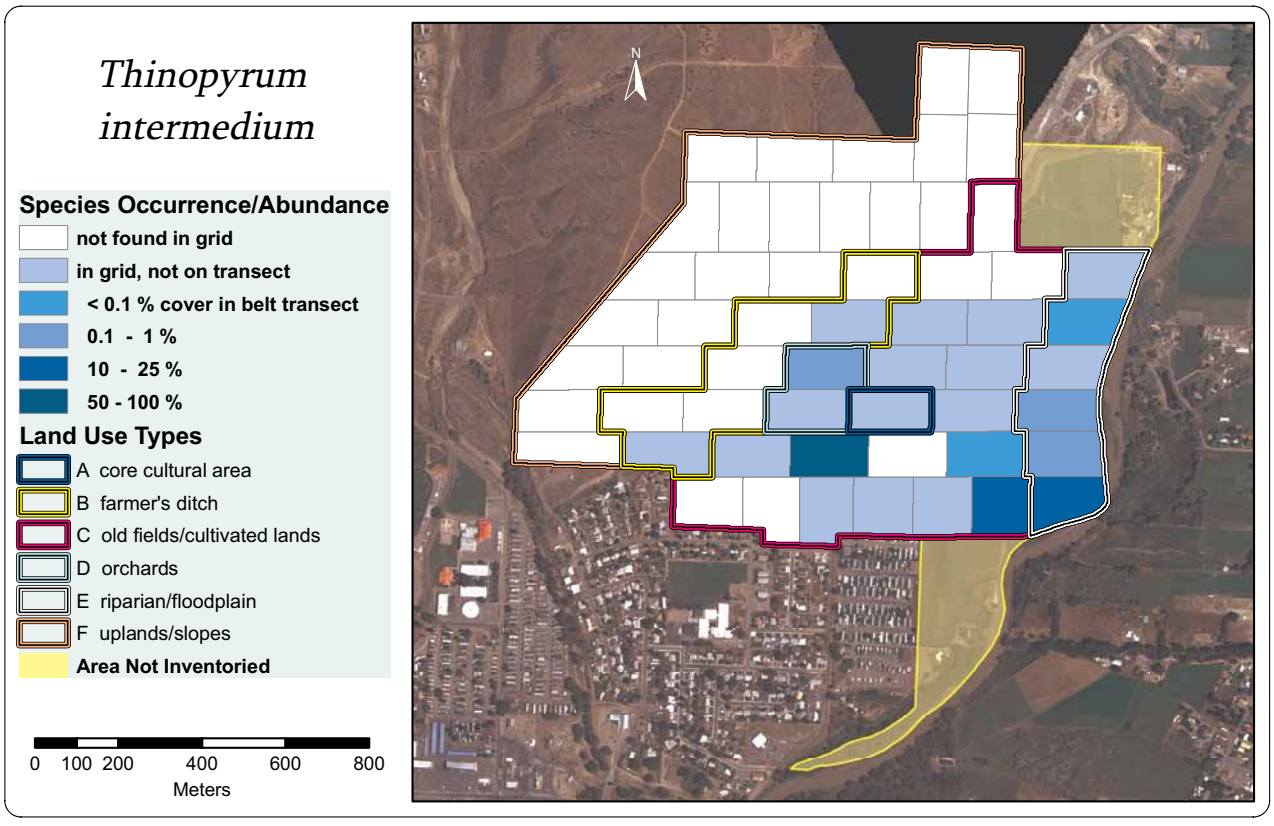

Figure E51. Species occurrence of *Thinopyrum intermedium* by grid cell.

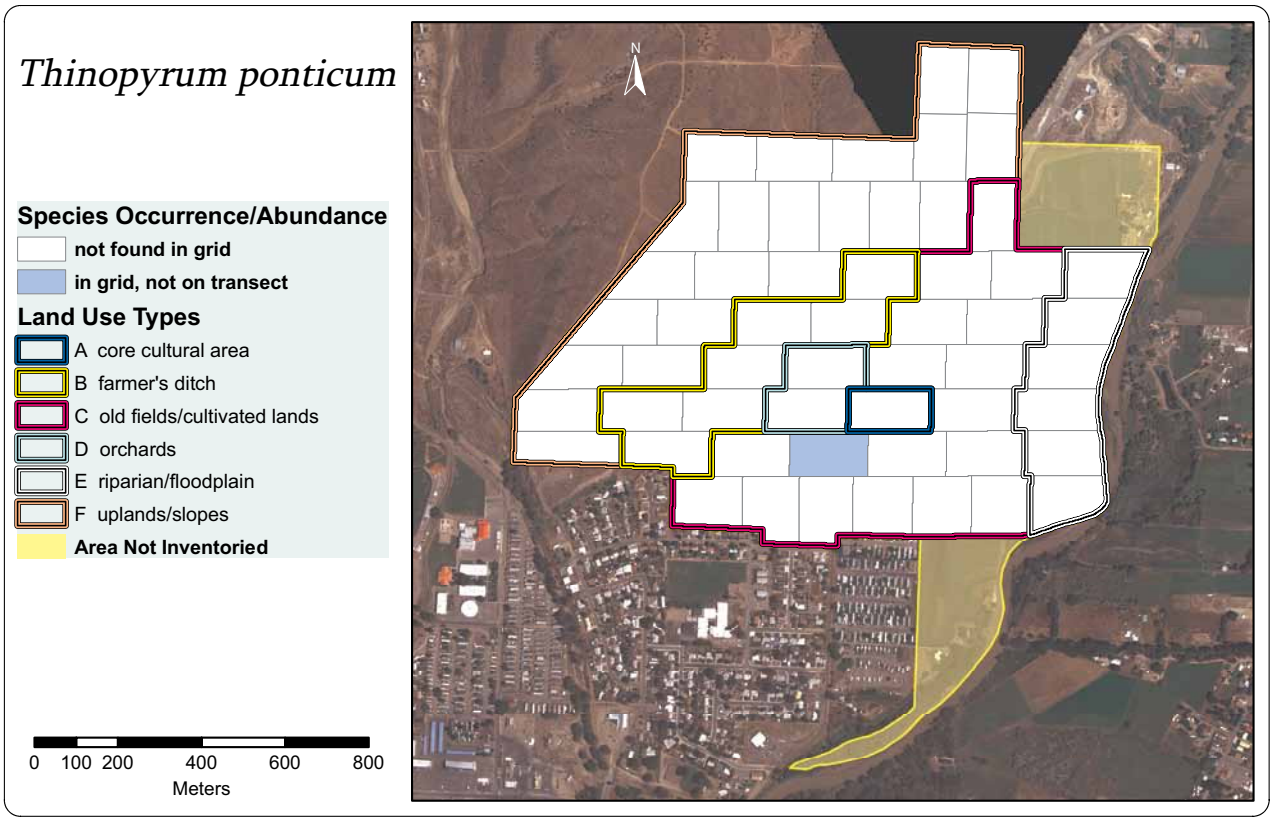

Figure E52. Species occurrence of *Thinopyrum ponticum* by grid cell.

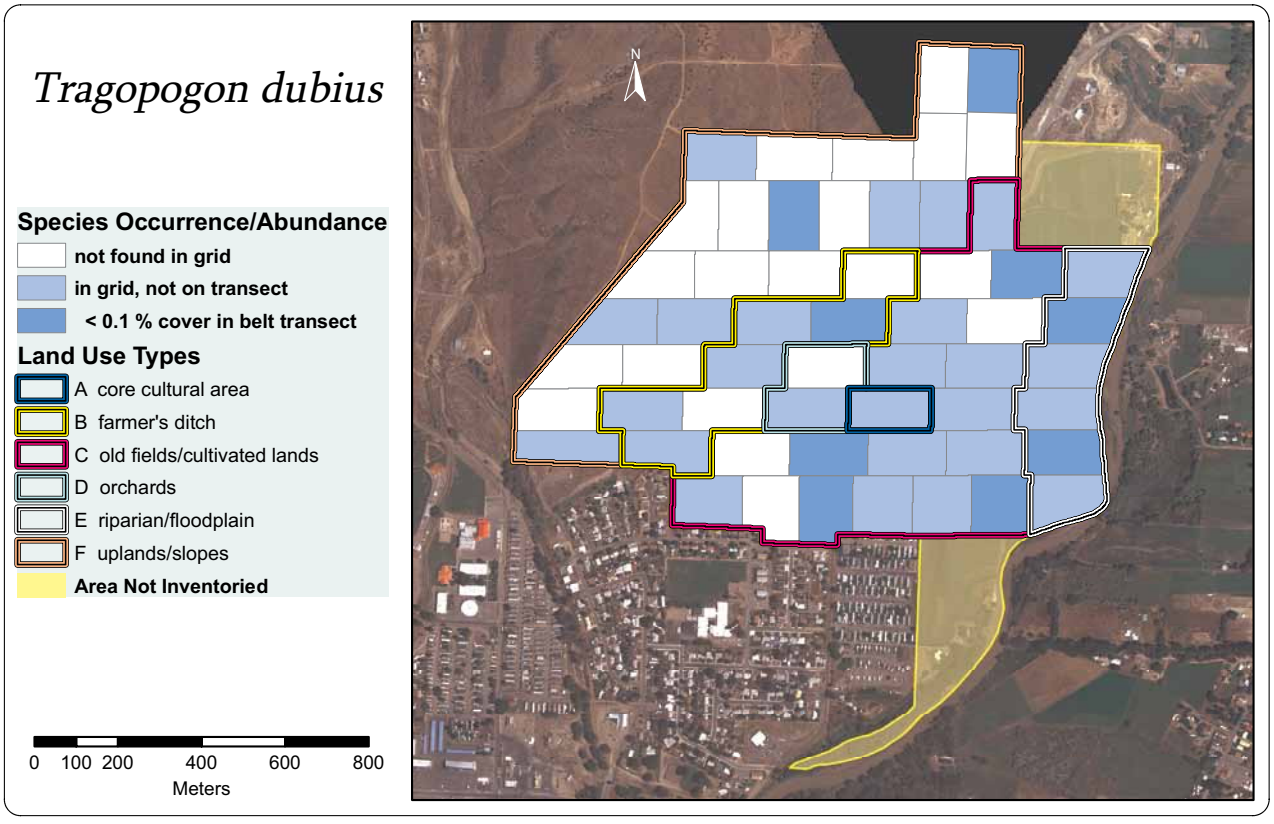

Figure E53. Species occurrence of *Tragopogon dubius* by grid cell.

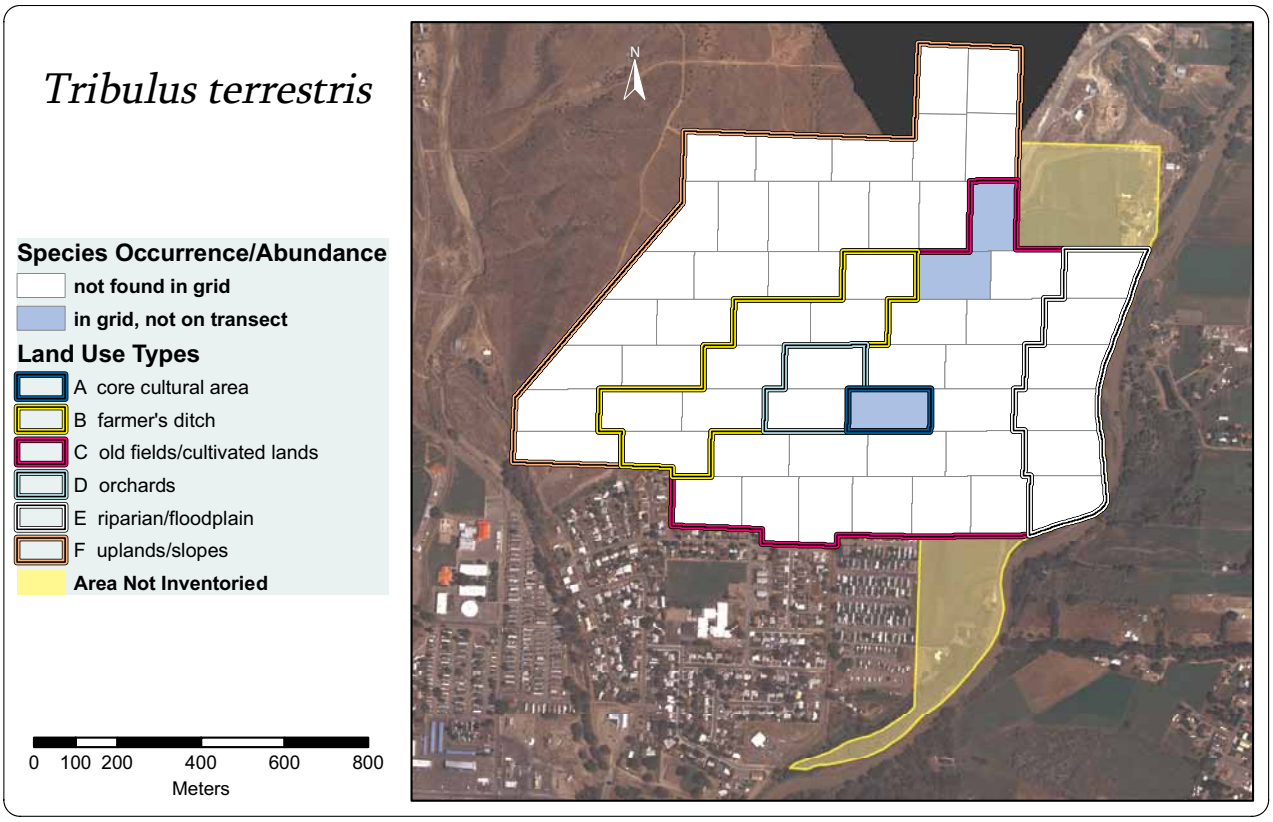

Figure E54. Species occurrence of *Tribulus terrestris* by grid cell.

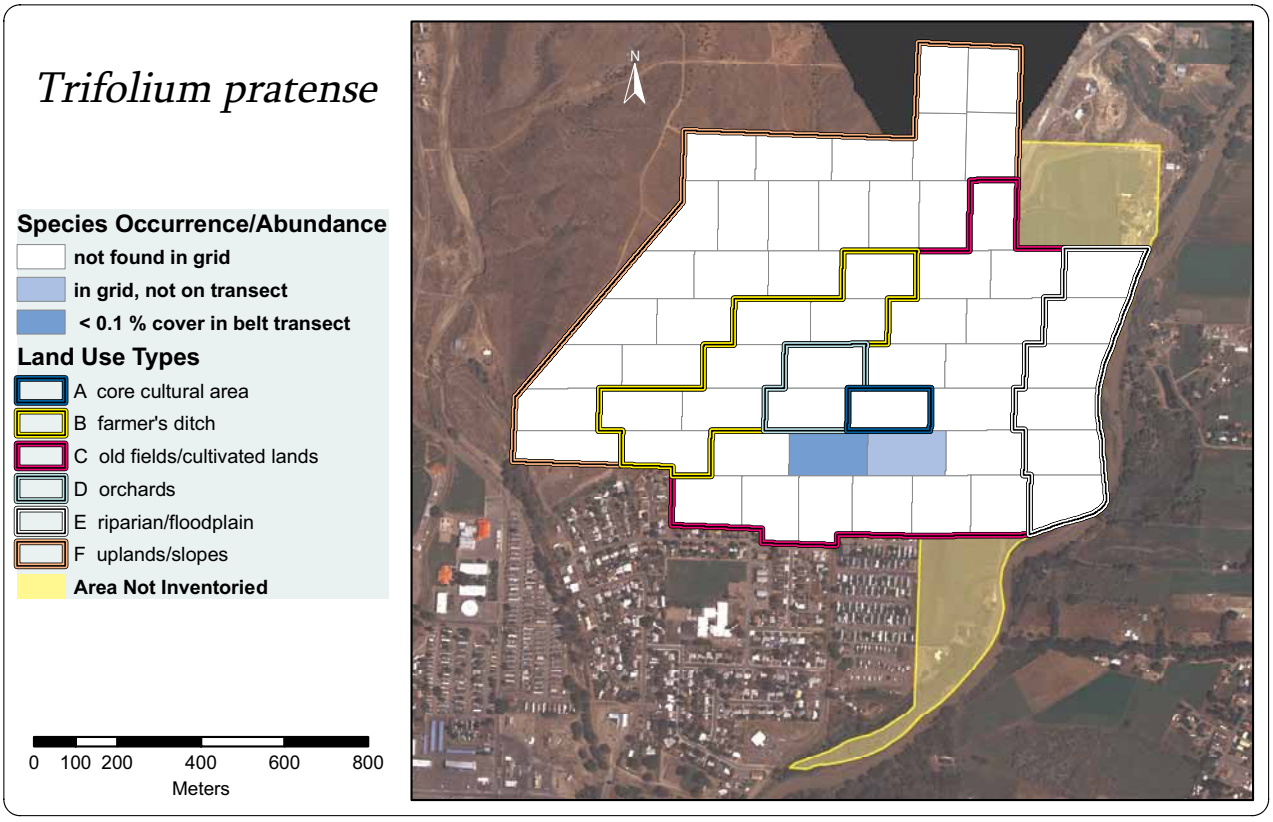

Figure E55. Species occurrence of *Trifolium pratense* by grid cell.

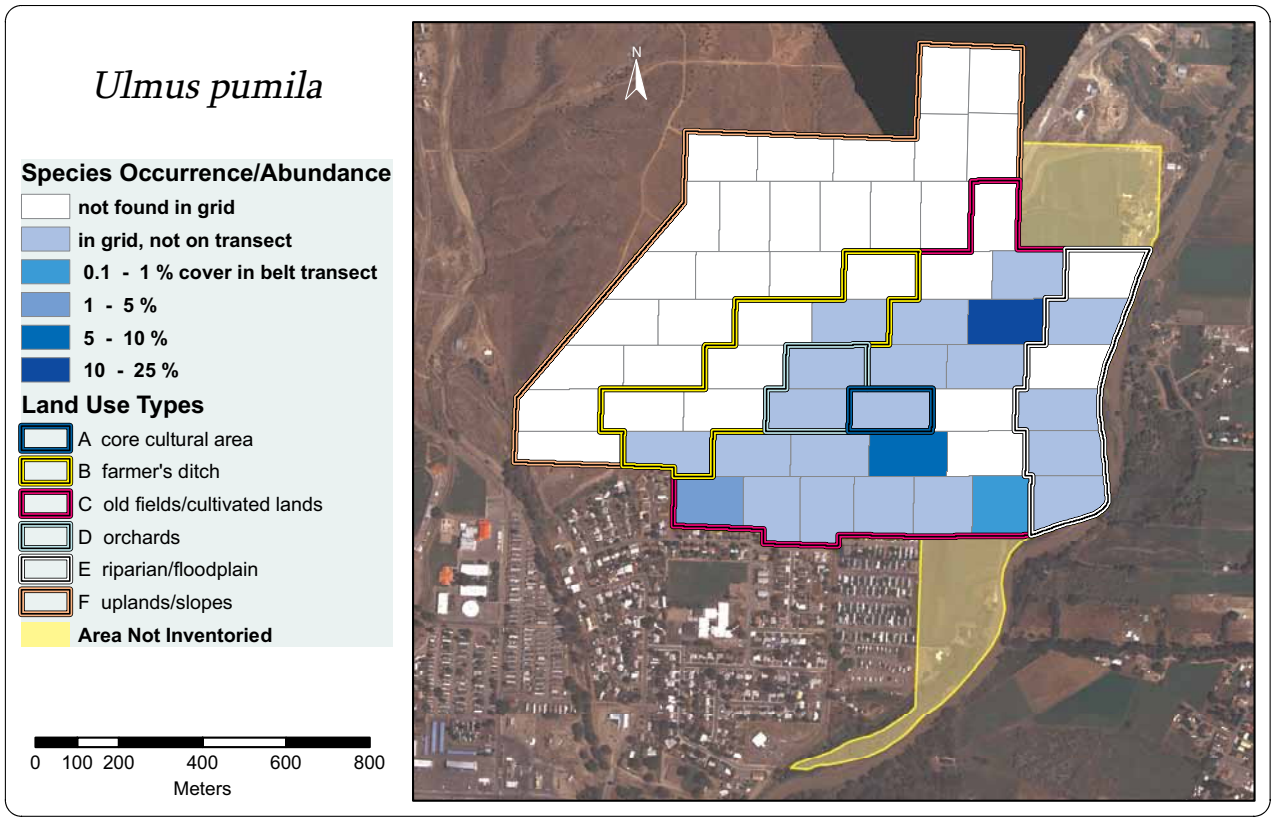

Figure E56. Species occurrence of *Ulmus pumila* by grid cell.

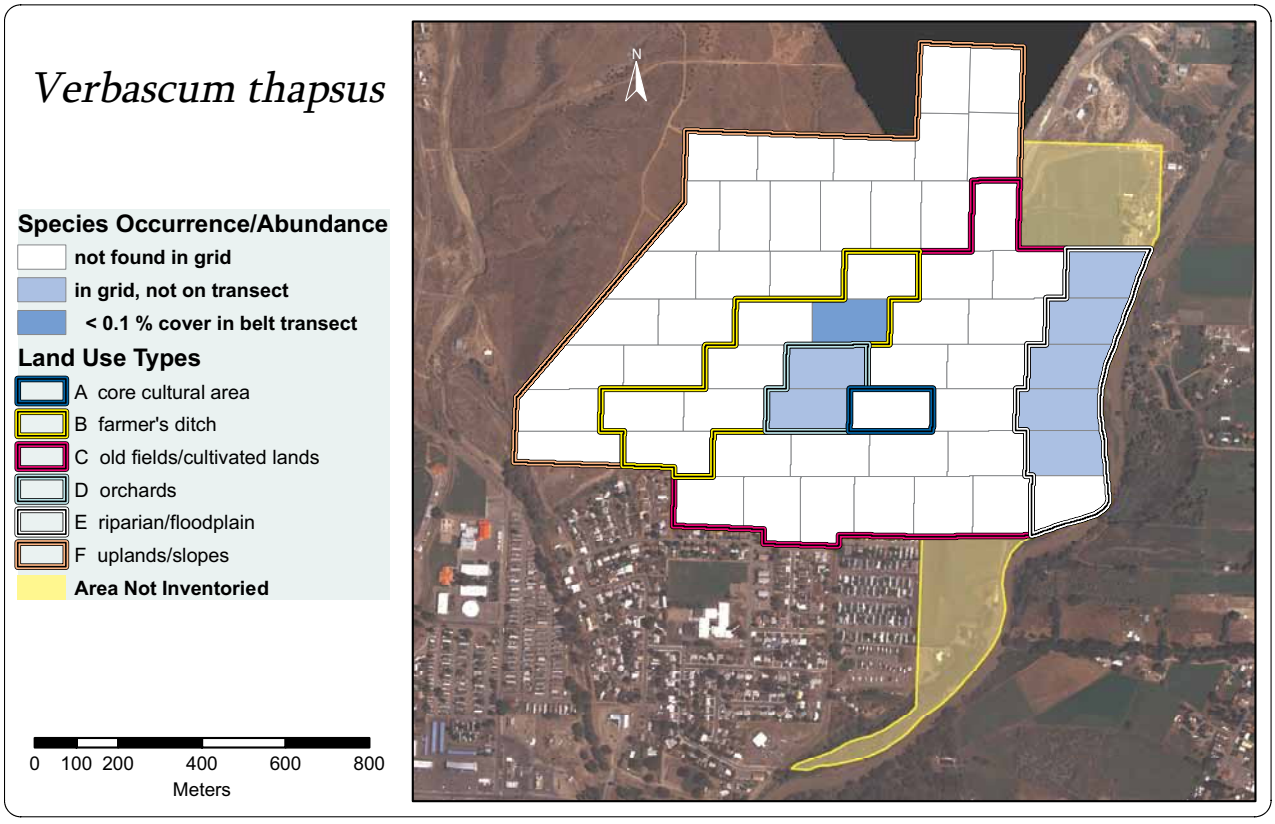

Figure E57. Species occurrence of *Verbascum thapus* by grid cell.

Appendix F. Inventory Datasheet

Exotic Plant Inventory Datasheet

Park _____ Date _____ Observers_____
Grid Cell Number _____ Belt Width (m) _____ Waypoint Numbers _____

Species	Cover Class	Present in Grid Cell (check)

Cover Class Scale for Foliar Cover Estimation:

Cover Range	<0.1%	0.1 - 1%	1-5%	5-10%	10-25%	25-50%	50-100%
Code	1	2	3	4	5	6	7
Belt Width	Upper Cutpoint	Upper Cutpoint	Upper Cutpoint	Upper Cutpoint	Upper Cutpoint	Upper Cutpoint	
3 m belt	0.39 X 0.39	1.22 X 1.22	2.74 X 2.74	3.87 X 3.87	6.12 X 6.12	8.66 X 8.66	
4 m belt	0.45 X 0.45	1.41 X 1.41	3.16 X 3.16	4.47 X 4.47	7.07 X 7.07	10 X 10	
5 m belt	0.5 X 0.5	1.58 X 1.58	3.54 X 3.54	5 X 5	7.91 X 7.91	11.18 X 11.18	
6 m belt	0.55 X 0.55	1.73 X 1.73	3.87 X 3.87	5.48 X 5.48	8.66 X 8.66	12.25 X 12.25	
7 m belt	0.59 X 0.59	1.87 X 1.87	4.18 X 4.18	5.92 X 5.92	9.35 X 9.35	13.23 X 13.23	

Appendix G. Aztec Ruins Plant Species List

This list was compiled by Glenn Rink, based on collections by Glenn Rink and Anne Cully from 2002-2007 (Rink and Cully 2008).

Scientific name	**Common name**	**Nativity**[b]
Abronia fragrans Nutt. ex Hook.	sweet sand verbena	N
Acer glabrum Torr. var. *glabrum*	Rocky Mountain maple	N
Acer negundo L.	boxelder	N
Acer saccharum Marsh	sugar maple	H
Achnatherum hymenoides (Roemer & J.A. Schultes) Barkworth	Indian ricegrass	N
Acroptilon repens (L.) DC.	Russian knapweed	E
Aegilops cylindrica Host	jointed goatgrass	E
Agropyron cristatum (L.) Gaertn.	crested wheatgrass	E
Agrostis capillaris L.	colonial bentgrass	E
Agrostis exarata Trin.	spike bentgrass	N
Agrostis perennans (Walt.) Tuckerman	autumn bentgrass	N
Agrostis stolonifera L.	redtop	N
Allium macropetalum Rydb.	large flower onion	N
Alopecurus pratensis L.	meadow foxtail	E
Alyssum desertorum Stapf	desert alyssum	E
Alyssum minus (L.) Rothm.	European alyssum	E
Amaranthus albus L.	pigweed	N
Amaranthus blitoides S. Wats.	prostrate pigweed	E
Amaranthus hybridus L.	smooth pigweed	N
Amaranthus powellii S. Wats.	Powell's pigweed	N
Ambrosia acanthicarpa Hook.	annual bursage	N
Ambrosia confertiflora DC.	ragweed	N
Apocynum L.	dogbane	N
Arabis pulchra var. *pallens* M.E. Jones	pale rockcress	N
Arabis selbyi (Rydb.) W.A. Weber	Selby's rockcress	N
Arctium minus Bernh.	burdock	E
Arenaria fendleri var. *tweedyi* (Rydb.) Maguire	Tweedy's sandwort	N
Aristida purpurea Nutt. var. *longiseta* (Steud.) Vasey	Fendler's threeawn	N
Aristida purpurea Nutt.[a]	purple threeawn	N
Artemisia campestris var. *scouleriana* (Hook.) Cronq.	field sagewort	N
Artemisia dracunculus L.	false tarragon	N
Artemisia filifolia Torr.	sand sagebrush	N
Artemisia ludoviciana Nutt. ssp. *ludoviciana*	Louisiana sagewort	N
Artemisia ludoviciana ssp. *albula* (Woot.) Keck	white sagebrush	N
Artemisia ludoviciana ssp. *redolens* (Gray) Keck	white sagebrush	N
Artemisia tridentata Nutt.	big sage	N
Asclepias asperula (Dcne.) Woods.	antelope horns	N
Asclepias speciosa Torr.	showy milkweed	N
Asclepias subverticillata (Gray) Vail	horsetail milkweed	N
Asparagus officinalis L.	asparagus	E

Appendix G, continued.

Scientific name	Common name	Nativity
Astragalus missouriensis Nutt.	Missouri milkvetch	N
Astragalus mollissimus var. *thompsoniae* (S. Wats.) Barneby	Thompson woolly milkvetch	N
Astragalus nuttallianus var. *austrinus* (Small) Barneby	small flowered milkvetch	N
Astragalus nuttallianus var. *micranthiformis* Barneby	turkeypeas	N
Atriplex canescens (Pursh) Nutt.	fourwing saltbush	N
Atriplex confertifolia (Torr. & Frém.) S. Wats.	shadscale	N
Atriplex micrantha Ledeb.	twoscale saltbush	E
Atriplex obovata Moq.	mound saltbush	N
Bidens cernua L.	burr marigold	N
Bidens frondosa L.	burr marigold	N
Bouteloua curtipendula (Michx.) Torr.	sideoats grama	N
Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths	blue grama	N
Brickellia oblongifolia Nutt.	narrowleaf brickellbush	N
Bromus catharticus Vahl	rescue brome	E
Bromus inermis Leyss.	smooth brome	E
Bromus japonicus Thunb. ex Murr.	Japanese brome	E
Bromus tectorum L.	cheat grass	E
Buchloe dactyloides (Nutt.) Engelm.	buffalograss	N
Calochortus aureus S. Wats.	golden mariposa lily	N
Camelina microcarpa DC.	littleseed falseflax	E
Capsella bursa-pastoris (L.) Medik.	shepherd's purse	E
Cardamine debilis D. Don	roadside bittercress	E
Cardaria chalapensis (L.) Hand.-Maz.	whitetop	E
Cardaria draba (L.) Desv.	whitetop	E
Cardaria pubescens (C.A. Mey.) Jarmolenko	hairy whitetop	E
Carduus nutans L.	musk thistle	E
Carex aquatilis Wahlenb.	water sedge	N
Castilleja integra Gray	wholeleaf Indian paintbrush	N
Castilleja linariifolia Benth.	Wyoming Indian paintbrush	N
Ceratocephala testiculata (Crantz) Bess.	bur buttercup	E
Cercocarpus montanus Raf.	mountain mahogany	N
Chaenactis stevioides Hook. & Arn.	Steve's pincushion	N
Chaenomeles speciosa (Sweet) Nakai	flowering quince	H
Chaetopappa ericoides (Torr.) Nesom	smallflower aster	N
Chamaesaracha coronopus (Dunal) Gray	green false nightshade	N
Chamaesyce chaetocalyx var. *chaetocalyx* (Boiss.) Woot. & Stand L.	bristlecup sandmat	N
Chamaesyce fendleri (Torr. & Gray) Small	Fendler's sandmat	N
Chamaesyce missurica (Raf.) Shinners	prairie sandmat	N
Chamaesyce serpyllifolia (Pers.) Small	thymeleaf sandmat	N
Chenopodium atrovirens Rydb.	pinyon goosefoot	N
Chenopodium desiccatum A. Nels.	narrowleaf goosefoot	N
Chenopodium fremontii S. Wats.	Fremont's goosefoot	N
Chloris virgata Sw.	feather windmill grass	N
Chorispora tenella (Pallas) DC.	blue mustard	E

Appendix G, continued.

Scientific name	Common name	Nativity
Chrysothamnus Greene*i* (Gray) Greene	Green's rabbitbrush	N
Chrysothamnus linifolius Greene	spearleaf rabbitbrush	N
Chrysothamnus viscidiflorus ssp. *viscidiflorus* (Hook.) Nutt.	yellow rabbitbrush	N
Cichorium intybus L.	chicory	E
Cicuta douglasii (DC.) Coult. & Rose	water hemlock	N
Cirsium arvense (L.) Scop.	Canadian thistle	E
Cirsium neomexicanum Gray	New Mexico thistle	N
Cirsium vulgare (Savi) Ten.	bull thistle	E
Clematis ligusticifolia Nutt.	western white clematis	N
Cleome serrulata Pursh	Rocky Mountain beeplant	N
Convolvulus arvensis L.	European bindweed	E
Conyza canadensis (L.) Cronq.	horseweed	N
Corydalis curvisiliqua ssp. *occidentalis* (Engelm. ex Gray) W.A. Weber	curvepod fumewort	N
Cryptantha bakeri (Greene) Payson	Baker's catseye	N
Cryptantha cinerea var. *jamesii* Cronq.	James' catseye	N
Cryptantha crassisepala (Torr. & Gray) Greene	thicksepal catseye	N
Cryptantha flava (A. Nels.) Payson	Plateau yellow catseye	N
Cryptantha fulvocanescens (S. Wats.) Payson	tawny catseye	N
Cuscuta indecora Choisy	pretty dodder	N
Cymopterus acaulis var. *fendleri* (Gray) Goodrich	Fendler's spring parsley	N
Cymopterus bulbosus A. Nels.	bulbous spring parsley	N
Cymopteruscf newberryi (S. Wats.) M.E. Jones	sweetroot spring parsley	N
Cyperus odoratus L.	fragrant flatsedge	N
Dactylis glomerata L.	orchardgrass	E
Delphinium nuttallianum Pritz. ex Walp.	low larkspur	N
Descurainia obtusa ssp. *adenophora* (Woot. & Stand L.) Detling	blunt tansymustard	N
Descurainia pinnata ssp. *glabra* (Woot. & Stand L.) Detling	western tansymustard	N
Descurainia sophia (L.) Webb ex Prantl	flaxweed tansymustard	E
Digitaria sanguinalis (L.) Scop.	hairy crabgrass	N
Dimorphocarpa wislizenii (Engelm.) Rollins	spectaclepod	N
Distichlis spicata (L.) Greene	desert saltgrass	N
Draba cuneifolia Nutt. ex Torr. *&* Gray	wedgeleaf draba	N
Dracocephalum parviflorum Nutt.	American dragonhead	N
Echinocereus fendleri (Engelm.) F. Seitz	Fendler's hedgehog cactus	N
Echinocereus triglochidiatus Engelm.	claretcup hedgehog	N
Echinochloa crus-galli (L.) Beauv.	barnyard grass	E
Echinochloa muricata var. *microstachya* Wieg.	rough barnyard grass	N
Elaeagnus angustifolia L.	Russian olive	E
Eleocharis palustris (L.) Roemer & J.A. Schultes	common spikerush	N
Eleocharis parishii Britt.	Parish's spikerush	N
Elymus alaskanus ssp. *latiglumis* (Scribn. & J.G. Sm.) A. Löve	Alaskan wheatgrass	N
Elymus canadensis L.	Canada wildrye	N
Elymus elymoides ssp. *brevifolius* (J.G. Sm.) Barkworth, comb. nov. ined.	squirreltail	N
Elymus trachycaulus ssp. *trachycaulus* (Link) Gould ex Shinners	slender wheatgrass	N

Appendix G, continued.

Scientific name	Common name	Nativity
Ephedra cutleri Peebles	Cutler Mormon tea	N
Ephedra nevadensis S. Wats.	Nevada Mormon tea	N
Ephedra torreyana S. Wats.	Torrey's jointfir	N
Epilobium ciliatum Raf.	fringed willowherb	N
Equisetum arvense L.	field horsetail	N
Equisetum hyemale L.	scouringrush horsetail	N
Equisetum laevigatum A. Braun	smooth horsetail	N
Eragrostis pectinacea (Michx.) Nees ex Steud.	purple lovegrass	N
Eremopyrum triticeum (Gaertn.) Nevsky	annual wheatgrass	E
Ericameria nauseosa var. *glabrata* (Gray) Nesom & Baird	rubber rabbitbrush	N
*Erigeron concinnus (*Hook. & Arn.) Torr. *&* Gray	Navajo daisy	N
Erigeron divergens Torr. *&* Gray	spreading fleabane	N
Erigeron flagellaris Gray	trailing fleabane	N
Eriogonum cernuum Nutt.	nodding buckwheat	N
Eriogonum ovalifolium Nutt.	cushion buckwheat	N
Erioneuron pilosum (Buckl.) Nash	hairy tridens	N
Erodium cicutarium (L.) L'Hér. ex Ait.	filaree	E
Erysimum repandum L.	spreading wallflower	E
Escobaria vivipara (Nutt.) Buxbaum	spinystar	N
Euphorbia cuphosperma (Engelm.) Boiss.	spurge	N
Euphorbia spathulata Lam.	roughpod spurge	N
Euthamia occidentalis Nutt.	western goldenrod	N
Evolvulus nuttallianus J.A. Schultes	prostrate evolvulus	N
Forestiera pubescens var. *pubescens* Nutt.	stretchberry	N
Fraxinus velutina Torr.	velvet ash	H
Gaillardia pinnatifida Torr.	blanketflower	N
Gaura coccinea Nutt. ex Pursh	scarlet guara	N
Gaura mollis James	velvetweed	N
Gilia sinuata Dougl. ex Benth.	rosy gilia	N
Gleditsia triacanthos L.	honeylocust	H
Glycyrrhiza lepidota Pursh	wild licorice	N
Grindelia nuda Wood	curlytop gumweed	N
Grindelia squarrosa var. *squarrosa* (Pursh) Dunal	curlycup gumweed	N
*Gutierrezia sarothrae (*Pursh) Britt. & Rusby	snakeweed	N
Helianthus annuus L.	annual sunflower	N
Hesperostipa comata (Trin. & Rupr.) Barkworth	needle and thread	N
Hesperostipa neomexicana (Thurb. ex Coult.) Barkworth	New Mexico needlegrass	N
Heterotheca villosa (Pursh) Shinners	hairy false goldenaster	N
Heterotheca villosa var. *foliosa* (Nutt.) Harms	hairy false goldenaster	N
Hordeum jubatum L.	foxtail barley	N
Hordeum marinum ssp. *gussonianum* (Parl.) Thellung	Mediterranean barley	E
Hordeum murinum ssp. *glaucum* (Steud.) Tzvelev	smooth barley	E
Hordeum pusillum Nutt.	little barley	N
Hymenopappus filifolius var. *cinereus* (Rydb.) I.M. Johnston	fineleaf hymenopappus	N

Appendix G, continued.

Scientific name	Common name	Nativity
Ipomopsis aggregata (Pursh) V. Grant	scarlet gilia	N
Ipomopsis longiflora (Torr.) V. Grant	white-flowered gilia	N
Ipomopsis pumila (Nutt.) V. Grant	dwarf gilia	N
*Isocoma pluriflora (*Torr. & Gray*)* Greene[a]	rayless goldenrod	N
Juncus saximontanus A. Nels.	Rocky Mountain rush	N
Juncus tenuis Willd.	field rush	N
Juniperus chinensis L.	Chinese juniper	H
Juniperus communis L.	common juniper	H
Juniperus deppeana Steud.	alligator juniper	H
Juniperus osteosperma (Torr.) Little	Utah juniper	N
Juniperus scopulorum Sarg.	Rocky Mountain juniper	H
Kochia scoparia (L.) Schrad.	common kochia	E
Krascheninnikovia lanata (Pursh) A.D.J. Meeuse & Smit	winterfat	N
Lactuca serriola L.	prickly lettuce	E
Lappula occidentalis var. *cupulata* (Gray) Higgins	flatspine stickseed	N
Lepidium densiflorum Schrad.	common pepperweed	N
Lepidium lasiocarpum Nutt.	hairypod pepperweed	N
Lepidium latifolium L.	broadleaf pepperweed	E
Lepidium perfoliatum L.	clasping pepperweed	E
Leptodactylon pungens (Torr.) Torr. ex Nutt.	common prickly gilia	N
Leymus triticoides (Buckl.) Pilger	creeping wildrye	N
Linum lewisii Pursh	Lewis' flax	H
Linum puberulum (Engelm.) Heller	desert flax	N
Lithospermum incisum Lehm.	fringed puccoon	N
Lolium perenne L.	perennial ryegrass	E
Lolium pratense (Huds.) S.J. Darbyshire	meadow ryegrass	E
Lonicera ruprechtiana Regel	Manchurian honeysuckle	H
Lonicera morrowii Gray	Morrow's honeysuckle	H
Lupinus ammophilus Greene	sand lupine	N
Lupinus brevicaulis S. Wats.	shortstem lupine	N
Lycium pallidum Miers	pale wolfberry	N
Lycopus americanus Muhl. ex W. Bart.	American bugleweed	N
Machaeranthera canescens (Pursh) Gray	hoary aster	N
Machaeranthera parviflora Gray	smallflower tansyaster	N
Machaeranthera pinnatifida ssp. *pinnatifida* (Hook.) Shinners	lacy tansyaster	N
Machaeranthera tanacetifolia (Kunth) Nees	tanseyleaf aster	N
Malus prunifolia (Willd.) Borkh.	plumleaf crabapple	H
Malva neglecta Wallr.	cheeseweed	E
Marrubium vulgare L.	horehound	E
Medicago lupulina L.	black medick	E
Medicago sativa L.	alfalfa	E
Melilotus officinalis (L.) Lam.	yellow sweetclover	E
Mentha arvensis L.	field mint	N
Mentzelia albicaulis (Dougl. ex Hook.) Dougl. ex Torr. & Gray	white blazingstar	N

Appendix G, continued.

Scientific name	Common name	Nativity
Mentzelia humilis (Gray) J. Darl.	gypsum blazingstar	N
Mentzelia multiflora var. *integra* M.E. Jones	Adonis blazingstar	N
Mentzelia multiflora var. *multiflora* (Nutt.) Gray	Adonis blazingstar	N
Mentzelia pumila var. *pumila* Nutt. ex Torr. & Gray	golden blazingstar	N
Mirabilis linearis (Pursh) Heimerl	narrowleaf four o'clock	N
Mirabilis multiflora (Torr.) Gray	Colorado four o'clock	N
Monolepis nuttalliana (J.A. Schultes) Greene	povertyweed	N
Morus alba L.	white mulberry	E
Morus nigra L.	black mulberry	E
Muhlenbergia asperifolia (Nees & Meyen ex Trin.) Parodi	alkali muhly	N
Oenothera albicaulis Pursh	white-stem evening-primrose	N
Oenothera elata ssp. *hirsutissima* (Gray ex S. Wats.) W. Dietr.	Hooker's evening-primrose	N
Oenothera pallida ssp. *runciniata* (Engelm.) Munz & W. Klein	pale evening-primrose	N
Oenothera villosa ssp. *strigosa* (Rydb.) W. Dietr. & Raven	hairy evening primrose	N
Onopordum acanthium L.	Scotch thistle	E
Opuntia erinacea Engelm. & Bigelow ex Engelm.[a]	grizzly pricklypear	N
Opuntia phaeacantha Engelm.	brownspine pricklypear	N
Opuntia polyacantha Haw.	plains pricklypear	N
Opuntia whipplei Engelm. & Bigelow	Whipple's cholla	N
Packera multilobata (Torr. & Gray ex Gray) W.A. Weber & A. Löve	lobeleaf grounsel	N
Panicum capillare L.	annual witchgrass	N
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper	N
Pascopyrum smithii (Rydb.) A. Löve	western wheatgrass	N
Penstemon lentus Pennell	handsome penstemon	N
Penstemon ophianthus Pennell	Arizona penstemon	N
Phacelia crenulata var. *corrugata* (A. Nels.) Brand	cleftleaf scorpion-weed	N
Phalaris arundinacea L.	reed canary grass	N
Phleum pratense L.	common timothy	E
Phlox austromontana Coville	mountain phlox	N
Physalis hederifolia Gray	ivyleaf groundcherry	N
Physalis longifolia Nutt.	longleaf groundcherry	N
Physaria acutifolia var. *acutifolia* Rydb.	southern twinpod	N
Picea abies (L.) Karst.	Norway spruce	H
Picrothamnus desertorum Nutt.	bud sagebrush	N
Pinus edulis Engelm.	two-needle pinyon	N
Plantago lanceolata L.	lanceleaf plantain	E
Plantago major L.	broadleaf plantain	N
Plantago patagonica Jacq.	woolly plantain	N
Pleuraphis jamesii Torr.	James' galleta	N
Poa bigelovii Vasey & Scribn.	Bigelow's bluegrass	N
Poa compressa L.	Canada bluegrass	E
Poa pratensis L.	Kentucky bluegrass	E
Polanisia dodecandra var. *trachysperma* (Torr. & Gray) Iltis	clammyweed	N
Polygala obscura Benth.	velvetseed milkwort	N

Appendix G, continued.

Scientific name	Common name	Nativity
Polygonum aviculare L.	prostrate knotweed	E
Polygonum lapathifolium L.	nodding smartweed	N
Polygonum pensylvanicum L.	Pennsylvania smartweed	N
Polygonum persicaria L.	spotted smartweed	N
Polypogon monspeliensis (L.) Desf.	rabbitsfootgrass	E
Populus angustifolia James	narrowleaf cottonwood	N
Populus deltoides Bartr. ex Marsh.	plains cottonwood	N
Populus fremontii S. Wats.	Fremont cottonwood	N
Populus x *acuminata* Rydb. (pro sp.)	lanceleaf cottonwood	N
Portulaca oleracea L.	common purslane	N
Prunus armeniaca L.	apricot	H
Purshia tridentata (Pursh) DC.	antelope bitterbrush	N
Pyracantha coccinea M. Roemer	scarlet fi rethorn	H
Ranunculus cymbalaria Pursh	alkali buttercup	N
Ranunculus macounii Britt.	Macoun buttercup	N
Ranunculus sceleratus var. *multifidus* Nutt.	blister buttercup	N
Ratibida columnifera (Nutt.) Woot. & Standl.	prairie coneflower	N
Rhamnus L.	buckthorn	H
Rhus trilobata Nutt.	skunkbush	N
Ribes aureum Pursh	golden currant	H
Robinia pseudoacacia L.	black locust	H
Rosa multiflora Thunb. ex Murr.	multiflora rose	H
Rosa woodsii var. *woodsii* Lindl.	Woods' rose	N
Rosa x borboniana Desportes (pro sp.)	Bourbon rose	H
Rumex crispus L.	curly dock	E
Rumex hymenosepalus Torr.	canaigre	N
Rumex salicifolius var. *mexicanus* (Meisn.) C.L. Hitchc.	Mexican dock	N
Salixaff matsudana Koidzumi	corkscrew willow	H
Salix exigua Nutt.	coyote willow	N
Salix gooddingii Ball	Goodding's willow	N
Salsola tragus L.	Russian thistle	E
Sarcobatus vermiculatus (Hook.) Torr.	greasewood	N
Schoenoplectus acutus var. *acutus* (Muhl. ex Bigelow) A.& D. Löve	hardstem bulrush	N
Schoenoplectus americanus (Pers.) Volk. ex Schinz & R. Keller	American bulrush	N
Schoenoplectus maritimus (L.) Lye	cosmopolitan bulrush	N
Sclerocactus cloveriae Heil & Porter	Clover's fishhook cactus	N
Scorzonera laciniata L.	cutleaf vipergrass	E
Senecio flaccidus Less.	threadleaf groundsel	N
Senecio spartioides var. *multicapitatus* (Greenm. ex Rydb.) Welsh	ragwort groundsel	N
Setaria viridis (L.) Beauv.	bottlegrass	E
Silene antirrhina L.	catchfly	N
Sisymbrium altissimum L.	tumble mustard	E
Sisymbrium irio L.	rocket mustard	E
Solanum douglasii Dunal	greenspot nightshade	N

Appendix G, continued.

Scientific name	Common name	Nativity
Solanum elaeagnifolium Cav.	silverleaf nightshade	N
Solanum rostratum Dunal	buffalobur	N
Solidago canadensis L.	Canada goldenrod	N
Solidago velutina DC.	sparse goldenrod	N
Sonchus asper (L.) Hill	prickly sowthistle	E
Sonchus oleraceus L.	common sowthistle	E
Sphaeralcea coccinea ssp. *elata* (E.G. Baker) Kearney	scarlet globemallow	N
*Sphaeralcea digitata (*Greene*)* Rydb.	juniper globemallow	N
Sphaeralcea fendleri ssp. *fendleri* Gray	Fendler's globemallow	N
Sphaeralcea incana ssp. *cuneata* Kearney	soft globemallow	N
Spiraea virgata Franch.	spirea	H
Spiraeax vanhouttei (Briot) Carr.	Van Houtt's spirea	H
Sporobolus airoides (Torr.) Torr.	alkali sacaton	N
Sporobolus contractus A.S. Hitchc.	spike dropseed	N
Sporobolus cryptandrus (Torr.) Gray	sand dropseed	N
Stanleya pinnata (Pursh) Britt.	desert princesplume	N
Stephanomeria pauciflora (Torr.) A. Nels.	wire lettuce	N
Streptanthella longirostris (S. Wats.) Rydb.	longbeak streptanthella	N
Streptanthus cordatus Nutt.	heartleaf twistflower	N
Suaeda moquinii (Torr.) Greene	alkali seepweed	N
Symphyotrichum falcatum var. *commutatum (*Torr. *&* Gray) Nesom	white prairie aster	N
Symphyotrichum lanceolatum ssp. *hesperium* (Gray) Nesom	white panicle aster	N
Syringa vulgaris L.	common lilac	H
Tamarix chinensis Lour.	saltcedar	E
Taraxacum officinale G.H. Weber ex Wiggers	dandelion	N
Tetradymia spinosa Hook. & Arn.	spiny horsebrush	N
Tetraneuris ivesiana Greene	Ives' fournerved daisy	N
Thelesperma megapotamicum (Spreng.) Kuntze	Hopi tea greenthread	N
Thinopyrum intermedium (Host) Barkworth & D.R. Dewey	intermediate wheatgrass	E
Thinopyrum ponticum (Podp.) Z.-W. Liu & R.-C. Wang	tall wheatgrass	E
Townsendia annua Beaman	annual Townsend daisy	N
Tragopogon dubius Scop.	common salsify	E
Tribulus terrestris L.	goathead	E
Trifolium pratense L.	red clover	E
Trifolium repens L.	white clover	E
Typha latifolia L.	common cattail	N
Ulmus pumila L.	Siberian elm	H
Verbascum thapsus L.	common mullein	E
Verbena bracteata Lag. & Rodr.	prostrate verbena	N
Verbesina encelioides var. *exauriculata* (Robins. & Greenm.) J.R. Coleman	golden crownbeard	N
Veronica anagallis-aquatica L.	water speedwell	N
Vinca minor L.	common periwinkle	H
Vulpia octoflora (Walt.) Rydb.	sixweeks fescue	N
Xanthium L.	cocklebur	N

Appendix G, continued.

Scientific name	Common name	Nativity
Xanthium strumarium L.	cocklebur	N
Yucca angustissima Engelm. ex Trel	narrowleaf yucca	N
Yucca baccata Torr.	banana yucca	N
Yucca elata (Engelm.) Engelm.	soaptree yucca	H
Zea mays L.	corn	H
Zigadenus paniculatus (Nutt.) S. Wats.	foothill deathcamas	N

[a] Observed during vegetation mapping sampling.

[b] Nativity: N = native plant species, E = exotic, or not from the North American continent, H = horticultural (planted).

Note: List compiled by Glenn Rink, based on collections by Glenn Rink and Anne Cully, 2002–2007.

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