A PRELIMINARY COARSE-SCALE VEGETATION MAP OF THE CITY OF FLAGSTAFF, ARIZONA: DRAFT FINAL REPORT, 4 DECEMBER 2009

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INTRODUCTION

Vegetation cover and wildlife habitat are important planning for comprehensive planning of urban areas. We here provide a draft, preliminary coarse-scale (section-based) vegetation map of the City of Flagstaff to improve understanding of the area, distribution, composition, and condition of wildlife habitat within and adjacent to the City borders. We used 2007 aerial overflight photography and geographic information from the City to describe vegetation cover patterns. We visited several sections to qualitatively evaluate vegetation patterns. In addition, we interviewed several local biologists regarding habitat issues in the Flagstaff area. We compiled those data and present preliminary results to the City for consideration in on-going planning efforts.

METHODS

Zoning and Land Use Cover

We acquired 2007 aerial overflight imagery from the City, as well as City geographic information systems (GIS) layers. We mapped zoning data onto the photographic imagery, and compiled area by zoning designation for each section of City land. We condensed land use categories into the following: building, industrial, roads and roadsides, rural, suburban, urban, unknown, and non-City lands within the perimeter of the City, and unclassified lands. As the overlays often revealed that unclassified lands were unmapped roadways, we added the unclassified lands to the roadways, where appropriate. We summed these covers to calculate the area of City and non-City lands. As the quality of the survey data in the City GIS varied by section, we also visually estimated the percent area occupied by impermeable anthropogenic activities and features in each section.

Vegetation Cover

We inspected each section containing City land for vegetation cover patterns. Vegetation cover types in this study included:

* Native mixed conifer - *Quercus* forest & woodland (dominated by ponderosa pine, with generally subdominant Gambel oak, and native *Juniperus*)
* Non-native deciduous and mixed conifer shrub, woodland, and forest (dominated by aspen, elms and Lombardy poplar, with subdominant fruit trees, non-indigenous

cottonwoods, maples, lilac, and other ornamental trees and shrubs)
* Native hillslope (chaparral shrub and woodland taxa)
* Native meadow (dominated by blue grama, muttongrass, other grasses, and herbs)
* Disclimax meadows (usually dominated by non-native weeds and often sparsely vegetated)
* Lawn and yard groundcovers (especially non-native grasses, such as Kentucky bluegrass)
* Riparian meadow (usually dominated or co-dominated by native grasses)
* Open water

Habitat and Fauna

We met with several biologists to discuss important habitats within the City limits, including Paul Beier (NAU School of Forestry) and Dr. Tina Ayers (NAU Deaver Herbarium). Their observations are being annotated into a GIS database, and additional experts are being invited to comment on this work. We also compiled additional information on the flora and fauna of Flagstaff from collections at the Museum of Northern Arizona, Northern Arizona University, Arizona State University, and the University of Arizona.

Caveats

This vegetation mapping effort is a coarse initial effort, designed to very generally describe vegetation and habitat patterns within the City limits. Although we are very familiar with several of the sections mapped, and able to qualitatively evaluate of understanding of vegetation patterns, this first effort has not been rigorously ground-truthed. As a first step, the data presented here provide a general indication of City vegetation cover and habitat, however, additional refinement of the vegetation map may warrant consideration by City planners.

RESULTS AND CONCLUSIONS

Land Use and Zoning

Flagstaff occupies parts of 72 sections, for a total of approximately 39,437 ac (61.6 mi^2), with approximately 67 percent rural land (Table 1; Appendix A). As such, much natural land and native wildlife habitat exists within the City limits.

Land use and zoning compilation was limited by data coverage and quality. While we were able to roughly calculate cover by zoning class, considerable uncertainty exists around these values (Appendix A). We recommend that the City continue to improve and make more accurate its GIS coverage to facilitate future planning efforts.

Table 1: Land use and zoning area coverage estimates of the City of Flagstaff (CoF), AZ.

Land Use Cover Type	Area (acres)
Building	1316
Industrial	1717
Pavement, Unpaved Roads, and Roadside	3020
Rural	26274
Suburban	7406
Unknown	210
Urban	818
County Land Area in CoF City Limits	662
Total Area with County Land	40099
Total Area in CoF	39437
Open Water	69
Est'd Total Impermeable Area	4250

Vegetation Cover

We visually estimated the percent cover of woodland-forest and meadow-grassland habitats in the City, and using the GIS-derived areas above, estimated the area of cover of those habitat types (Table 2; Appendix A). Overall, we estimate that 55 mi^2 (square miles; 35,200 acres) of vegetation cover exists within the Flagstaff City limits, nearly 89% of the total area of the City. However, much of the vegetation in the central portions of Flagstaff is non-native.

Vegetation cover is strongly dominated by native coniferous forest and woodland (32.6 mi^2; 20,864 acres; or 59% of all vegetative cover). A strong gradient of tree species exists from the City edges to the center of town, shifting from native ponderosa pine in undeveloped areas, to ponderosa pine and aspen in outlying suburban areas, to non-native elm, Lombardy poplar, ornamental fruit trees, and various non-native birch, willow, maple, and other tree species. Also, within the City, the west side is more strongly dominated by aspen (all of which appear to have been planted), whereas elms appear to dominate East Flagstaff. Several non-native grass and herbs species are ubiquitous in Flagstaff, including cheatgrass.

Flagstaff encompasses approximately 9.1 mi^2 (5,824 acres) of native-dominated meadows (16% of the total City area; Table 2). However, non-native meadow/grassland habitats (lawns and disclimax fields) occupy 9.2 mi^2 (5,888 acres), slightly more area than that of native meadows within the City limits. Much of the landscape apparently formerly occupied by native meadows has been developed for suburban and urban uses, and native meadow habitat area in Flagstaff has consequently declined as the City grows.

Table 2: Vegetation cover by type and area within the City of Flagstaff, AZ.

Vegetation Cover Type	Area (acres)
Native Conifer + *Quercus* Forest & Woodland	20,850
Non-native Deciduous & Mixed Conifer Shrub, Woodland or Forest	1,405
Native Shrub and Woodland Hillslope	335
All Forest, Woodland, Shrub Area	**22,255**
Native Meadow	5,807
Disclimax Meadow	3,283
Lawn & Yard	2,590
Riparian Meadow	869
All Meadow Cover	**12,550**
Estimated Total Vegetated Area (acres)	**35,210**

Non-native plant species are numerous and play large ecological roles (e.g. natural and human-caused fire; shelter, cover, and food for wildlife and humans; water use; disturbance of native systems) in the Flagstaff area. Non-native ornamental tree and shrub species are abundant in suburban neighborhoods, including exotic cottonwoods, maples, fruit trees, and lilacs, and invasive, non-native trees include elms, Russian olive, and Lombardy poplar. Non-native grass and herb species include: cheatgrass, Kentucky bluegrass, and a host of non-native herbs. A survey of Buffalo Park, a representative native-dominated meadow in Flagstaff revealed at least 81 species, of which at least 20 (24.7 percent) of the species were non-native (Table 3).

Table 3: A preliminary list of non-native plants in Buffalo Park, Flagstaff, AZ.

Scientific Name	Common Name
Ambrosia spp.	Ragweed
Bidens spp.	Beggar's tick
Bromus inermis	Smooth brome
Bromus tectorum	Cheatgrass
Centaurea	Gnapweed
Chenopodium	Lamb's quarters
Chenopodium graveolus	Field goosefoot
Convolvulus	Morning glory
Dactylis glomerata	Orchardgrass
Eragrostis sp.	Lovegrass
Linaria dalmatica	Toadflax
Malva parviflora	Cheeseweed
Marrubium vulgare	Horehound
Melilotus albus	White sweetclover
Melilotus officinale	Yellow sweetclover
Verbascum thapsus	Mullein
Poa pratensis	Kentucky bluegrass
Taraxacum officinale	Dandylion
Tragopogon dubius	Salsify
Triticum aestivum	Domestic wheat

Habitat

Plant habitats of interest in Flagstaff include escarpments, such as those on the east, south and west sides of Buffalo Park, and other lava-flow edges in town. The south side of Mt. Elden contains a remarkable assemblage of plant species, many normally found at much lower elevations due to a combination of unique geomorphology and an expansive south-facing aspect. Also of interest are riparian channels, both perennial and ephemeral. Riparian channels contain among the highest biotic diversity of all habitat types in the southwestern US, provide critical habitat for species that are in decline across Arizona, and provide important corridors for wildlife movements and plant dispersal. We hope to assemble a list of the plant species that occur within the City limits in the near future.

Our interviews with wildlife biologists indicate that several areas are important as wildlife habitat. Among the most important of these are perennial or near-perennial riparian channels (e.g., the lower Rio de Flag). Also, escarpments may be used by wildlife to move through the landscape and provide habitat or cover for secretive species such as mesocarnivores (foxes, skunks, and snakes) and larger carnivores (bears and cougars). The edges of Mt. Elden are of particular interest as a wildlands-urban interface, and because several springs exist on the southern side of the mountain, which naturally draw wildlife. We hope to assemble a list of the invertebrate and vertebrate species documented from Flagstaff in the near future.

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APPENDIX A:

SEPARATE ELECTRONIC DATA FILES

1) Excel database "Flagstaff Veg Map Data 091206_Stevens Consulting"

2) ArcMap 3.0 GIS layers "CoF Habitat Map"