Using Population Distribution Forecasts and GIS Technology to Assess Potential Hardwood Loss in the Northern Sacramento Valley[1]

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Abstract: *Since its inception, The Northern Sacramento Valley Sustainable Landscapes Project (SLP) has focused on facilitating discussions on long-term management of the extensive oak woodland landscape. The SLP is using geographical information system (GIS) technology to begin a spatial assessment of present and future population patterns. With a GIS, models depicting potential buildout based on current land use and growth projections can be developed. These models can be used as a visual tool to help planners, decision makers, and the interested public to examine potential impacts, initiate discussion, and to formulate workable growth strategies in the oak woodland interface.*

Since early 1994, The Northern Sacramento Valley Sustainable Landscapes Project (SLP) has focused on facilitating informed discussions between public policy makers and resource stakeholders, including the general public, on long-term management of the extensive oak woodland landscape *(fig. 1)*.[4] As part of its goal to develop an acceptable framework for discussing issues related to sustainability, the SLP has chosen to use geographical information system (GIS) technology. By incorporating county and city land-use plans and other relevant information into a GIS, it is possible to begin a spatial assessment of present and future population patterns.

Figure 1—Northern California Sustainable Landscape counties

[1]An abbreviated form of this paper was presented at the Symposium on Oak Woodlands: Ecology, Management, and Urban Interface Issues, March 19-22, 1996, San Luis Obispo, California. Base information and data for this paper are the result of research conducted by the junior author and are described in a report by Radabaugh (1995).

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[4]The Northern Sacramento Valley Sustainable Landscape Project includes Butte, Colusa, Glenn, Shasta and Tehama Counties. These five counties contain approximately 7 percent of California's land area. Oak woodlands cover approximately 21 percent of the landscape in the five county region and the region accounts for approximately 14 percent of the state's oak woodland inventory based on Pillsbury (1991).

Like most of California's inland valleys, the population of the northern Sacramento Valley is forecast to more than double by the year 2040 (California Department of Finance 1993). Population growth in the region typically takes the form of low density development (averaging 1 to 3 dwelling units per acre) within the planning areas of incorporated cities. In addition, rural residential lots of 1 to 40 acres per dwelling unit develop around farming communities and in oak woodland and timbered landscapes. Although incorporated cities contain some of the lowest urban densities found in California, this region nonetheless contains extensive acreage of rural residential development.

A doubling of population in the region is expected within the next 20 years. This implies that additional land in the region will be placed under development pressure for urban and rural residential uses. If this pattern of lower-density urban development and extensive rural residential development is projected past the 15- to 20-year time frames of local area plans, it is clear that significant oak woodland acreage will be affected.

Methods

A review of past and present population patterns and growth trends in the five-county SLP region resulted in series of GIS coverages depicting future land use and population density (Radabaugh 1995). Land-use polygons were identified, and population distribution forecasts were made on the basis of key factors, including

- An estimate of existing population based on the 1990 Census, county assessors records, and other data;
- An estimate of population buildout potential described in terms of average density; and
- The estimated average annual population growth rate to be expected within each polygon.

Paper maps of each of the five counties were prepared and digitized using one of five general land-use categories. These categories included

- *Incorporated city spheres of influence* or areas specifically designated for future urban growth and expansion,
- *Unincorporated communities* where water and/or sewer services are provided and residential buildout density is less than one dwelling unit per acre,
- *Rural residential lands* where buildout density is between 1 and 40 acres per dwelling unit and resource production from the parcel is not the primary land use. It is generally located on agricultural, grazing and range, and timber-producing land;
- *Agricultural lands,* which were divided into small-scale agriculture (less than 20 acres per dwelling unit) and large-scale agriculture (greater than 20 acres); and
- *Other resource-producing lands* including lands used for grazing, timber production, mining, wildlife habitat, and open space. Resource lands were divided into foothill rural and timber. Acreages are greater than 40 acres per dwelling unit.

For the purposes of assessing impacts in the oak woodland interface, the first three categories were considered sensitive to population change. As more information like riparian data along the Sacramento River and its tributaries become available, impacts in Valley Oak areas along the river can be added as well.

Information from data collection was digitized using ArcInfo software, a GIS product developed by Environmental Systems Research Institute (ESRI) in

Redlands, California. ESRI desktop GIS software, ArcView, was used for plotting maps and for statistical analysis.

Butte County Demonstration

Butte County is the most populous of the five-county SLP area. It is estimated that 83 percent of its 1995 population resides within one of five city sphere-of- influence planning areas. The Chico sphere accounted for 44 percent of the County's 1995 population, but only slightly greater than half that population lived within the incorporated territory. Population growth in Butte County's urban areas has steadily increased relative to non-urban areas since the mid-1970's.

Although Butte County contains the region's largest urban area population, the population of its unincorporated community centers and towns is the smallest of the five-county area because of limited community water provisions and/or sewers in unincorporated non-urban areas. Nonetheless, Butte County has the second largest inventory of rural residential land and population, following Shasta County.

Butte County was the first area to be digitized and was used as a demonstration area for the purposes of this study. Potential development land-use polygons were digitized into the GIS. Land-use type, average density (in acres per dwelling unit), and annual growth rate (as a percent) were added into the data base for each polygon.

Digital map information developed by Pillsbury (1991) showing California hardwood types was obtained from the California Department of Forestry and Fire Protection (CDF) as a digital file (*fig. 2*).

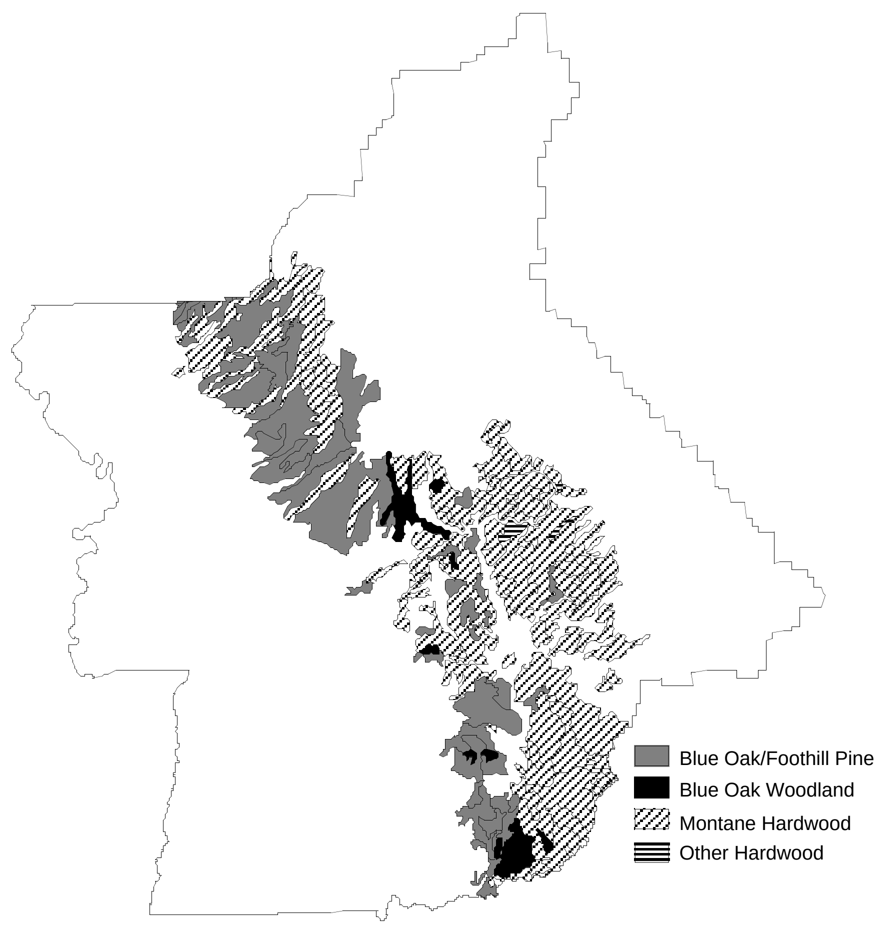

Figure 2—Butte County hardwoods

Using ArcView software, total acreage statistics within each hardwood type were generated.

Hardwood type	*No. of polygons*	*Acres*
Blue oak/foothill pine	49	82,828
Blue oak woodlands	9	10,608
Montane hardwoods	73	148,100
Other hardwoods	3	1,361

Examination of the impact of potential growth on the oak interface requires overlaying the land-use types layer with the hardwood layer. Incorporated city spheres, unincorporated communities, and foothill rural residential were used because they are population sensitive and have the greatest impacts in the oak woodland interface.

Because the purpose of this project is to examine the potential impact of development in the oak woodland interface, those land-use areas which do not lie within the hardwood region were deleted; i.e., the agricultural areas on the valley floor were skipped. In addition, the timber and foothill rural resource areas were deleted as their densities are greater than 40 acres per dwelling unit (*fig. 3*).

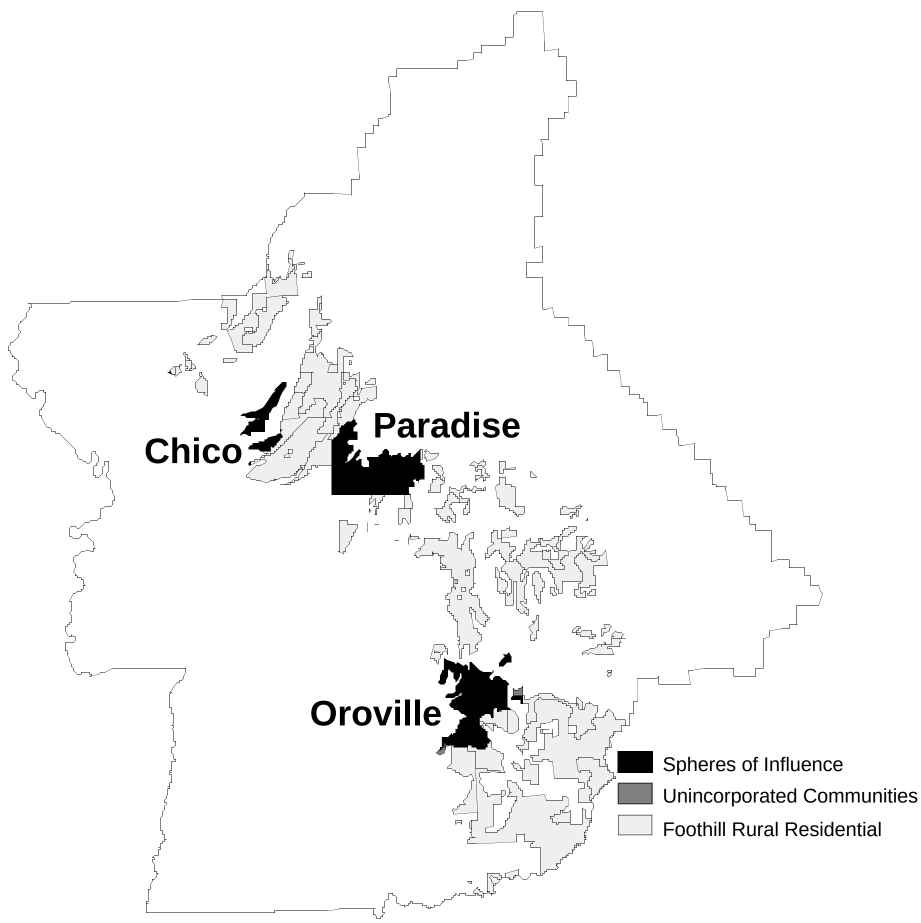

Figure 3—Projected buildout by land use type

When this step is completed and statistics are generated, the impacts of potential buildout within the oak woodland interface become very apparent, and the true extent of the foothill rural residential area becomes defined.

Land use type	*No. of polygons*	*Acres*
Incorporated city spheres	10	25,038
Unincorporated communities	2	330
Foothill rural residential (1-40 ac.)	113	100,484

Since population density statistics were also digitized, it is possible to break down the Foothill Rural Residential type by acres per dwelling unit.

Density	*No. of polygons*	*Acres*
Less than 1 acre per dwelling unit	12	25,358
1 - 2 acres per dwelling unit	2	39
2 - 5 acres per dwelling unit	11	4,405
5 - 10 acres per dwelling unit	15	9,048
11 - 20 acres per dwelling unit	44	24,902
20 - 40 acres per dwelling unit	42	62,091

When the buildout layer was overlaid with the hardwood layer, a third set of data was generated illustrating potential vegetation loss by hardwood type (*fig. 4*).

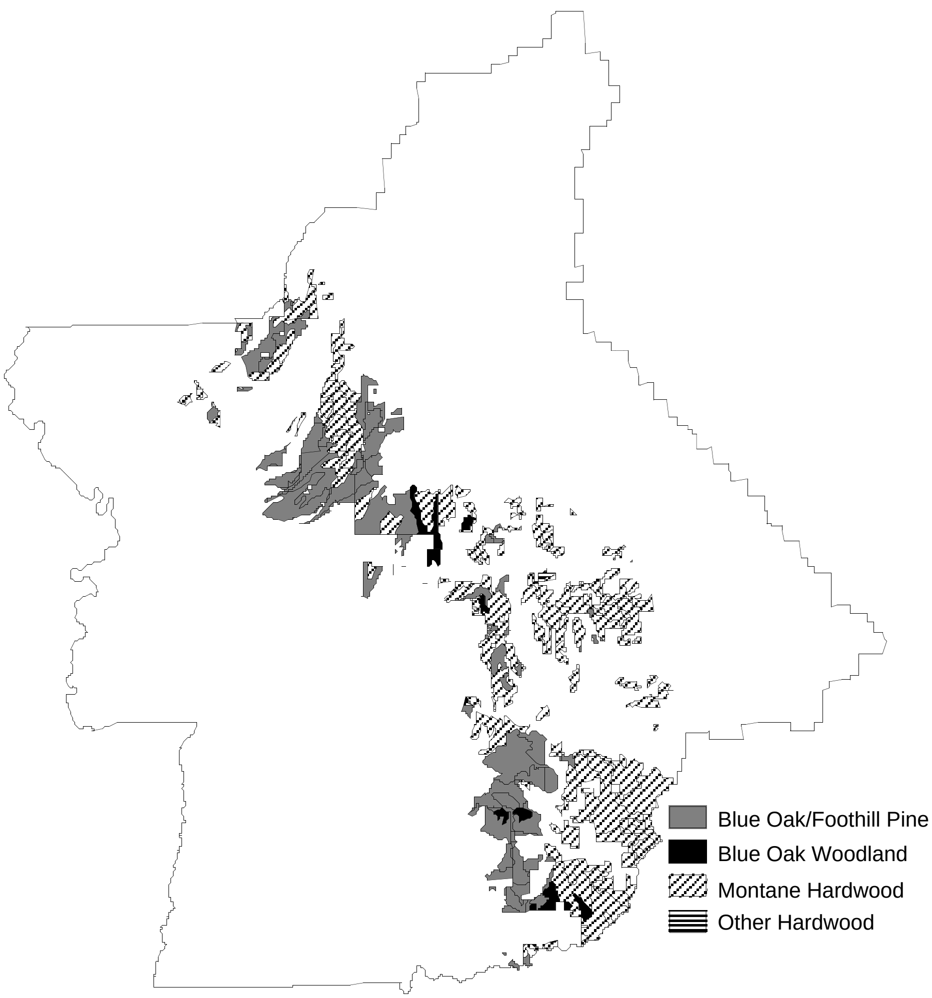

Figure 4—Potential buildout by hardwood types

Loss percentages can be easily calculated and statistical summaries can be generated as needed.

Hardwood type	*No. of polygons*	*Polygon increase*	*Acres*	*Percent of total impacted*
Blue oak/foothill pine	126	77	50,979	62
Blue oak woodlands	19	10	6,302	59
Montane hardwoods	239	166	74,390	50
Other hardwoods	3	0	351	26

Polygon increase shows the fragmentation of remaining hardwood stands if potential development continues with no restrictions. Statistics in Butte show a significant increase in the number of polygons as buildout occurs.

Impact statistics in Butte County, while significant, can be misleading and are open to debate. For instance, the impact of one dwelling unit per 40 acres may be significant or it may have little effect on oak habitat. That is not for me to debate here.

This information should not be used to stop development in Butte County. Rather, it should be used to guide responsible growth. Maps and statistical information merely give planners, decision makers and the interested public the ability to examine potential impacts, initiate discussion, and try to formulate workable growth strategies.

Implications and Conclusions

The ability to graphically illustrate growth projections in a GIS gives the SLP an important planning tool. The potential uses for this type of data are limitless. For instance:

- Incorporation of the SLP maps with other existing digital products like riparian, wetlands, soils, and land ownership data can be easily accomplished by a regional GIS data center like the Geographical Information Center at California State University, Chico (CSU, Chico);
- If a comprehensive GIS data base is developed at the land development and project permit level, it could be tailored to begin providing relatively low-cost natural resource and environmental baseline information to local planning agencies, developers, and interested citizens. A parallel already exists at many California State Universities. For instance, reconnaissance-level archeological information is currently provided at minimal cost to local governments by the Northeastern California Information Center at CSU, Chico;
- The improved ability to assess change in the oak woodland landscape on a comparative basis with other resources can lead to new or expanded ideas regarding oak woodland sustainability;
- Inclusion of a method to spatially assess the impacts of population growth on a variety of other natural resource components will likely lead to more related research in the region;
- A GIS data system is adaptable and can be easily updated to accommodate new spatial information. For instance, a multiagency mapping project is currently under way using Landsat satellite technology to classify California vegetation types. When these digital maps are complete, information can be brought into a GIS and used

to update existing oak woodland statistics; and

- Mapping provides a clear visual format for the area residents to understand relationships between land use and population growth. Low-cost software like ArcView makes desktop GIS and SLP data readily available to local decision makers who will ultimately decide the fate of the oak woodland interface.

References

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