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# Policy Implications of Growth Modeling and Environmental Assessment in the San Joaquin Valley of California

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## I. Executive Summary

In the next 40 years, the eight counties of the San Joaquin Valley are projected to double in population from 3.3 million to more than 7 million (Great Valley Center 2006). The region faces many challenges with respect to its capacity to accommodate this dramatic increase in population while maintaining its environmental infrastructure and preserving its diminishing natural resources.

In response to these growing pressures, Governor Schwarzenegger announced in June 2005 the formation of the California Partnership for the San Joaquin Valley (Partnership) to "…improve the economic well-being of the Valley and the quality of life of its residents" (Department of Business Transportation and Housing 2007). This 26-member Partnership, led by the Secretary of the Business, Transportation and Housing Agency, is composed of eight state government members (primarily cabinet level appointees), eight local government members (primarily members of county boards of supervisor) and eight private sector members (primarily representing leadership in a variety of business sectors). The region of focus for the Partnership included: San Joaquin, Stanislaus, Merced, Madera, Fresno, Tulare, Kings, and Kern Counties. The Partnership delivered the San Joaquin Valley Strategic Action Proposal, which provides recommendations for improving the economic conditions of the San Joaquin Valley, to the Governor in October 2006. However, the report focuses mostly on economic conditions and impacts rather than considering population growth impacts on the region's remaining environmental and natural resources.

The Information Center for the Environment (ICE) at UC Davis supported the Partnership by providing GIS data and growth allocation build-out scenarios. Based on input from the Partnership and the Great Valley Center, ICE developed and produced seven urban growth scenarios for the region that project to year 2050 using UPlan, a geographic information system (GIS) urban growth model (Johnston et al. 2006). The Partnership's Land Use, Housing and Agriculture (LUHA) Work Group and ICE developed these scenarios based on different goals (such as Compact—within current spheres of influence; Farmland Protection—prime farmland masked; I-5 to Hwy99 Exclusion—no growth between these highways; New Cities—create new cities in areas of low environmental impact; Great Cities—create "mega-cities" in concentrated regions) and they produced vastly different outcomes.

This paper focuses on two major issues. The first concerns the failure of the Governor's Partnership for the San Joaquin Valley's Strategic Planning Proposal to sufficiently address the importance of conserving environmental and biological resources. The Partnership's list of top priorities for action include health and well being, economic growth, and air quality, but fails to include such important considerations as loss of endangered species habitat and corridors, protection of open space, and conservation of threatened and endangered species. The Partnership's LUHA Work Group's recommendations do include these important issues, but these issues did not make it to the Partnership's overall list of priorities. Implications of this omission may be widespread since the seed grants that were intended to jumpstart major initiatives set forth in the Partnership's Proposal had to directly address one of the Partnership's overall recommendations in order to be considered for funding.

The second section of this paper discusses the seven growth scenarios and the implications of mapped future urban growth under those scenarios on a collection of biologically significant GIS layers. To develop an understanding of the interaction of the growth scenarios with the region's natural resource base, we combined the growth "footprint" for each scenario with each of the biological conservation priority layers. The growth scenarios reflect seven different policy directions that the region's leaders may choose when planning for growth in the upcoming several decades. Results showed that depending on the scenario chosen (and hence the policy emphasis), the magnitude of natural resources likely to be lost varies significantly. The scenario with the overall least ecological impact is the Compact Growth Scenario (Scenario 3), with Scenarios 6 (New Cities) and 7 (Great Cities) also fairly low in relative impact. Scenario 4 (Prime Farmland Protection) resulted in the largest decline in acreage of the 14 biological resources data layers we examined. Scenarios 5 (I-5 to Highway 99 Exclusion), 2 (East/West Road Improvement) and 1 (Status Quo) also showed relatively high negative impacts, although not as significant as Scenario 4.

## II. Introduction

The growth of human populations inevitably has an effect on the natural environment. As human populations continue to increase, so do the conflicts for land use. As urban areas expand, vital natural resources diminish. Once lost, most of these resources cannot be recovered. Over the long term, the cumulative impact of environmental degradation negatively affects human health and well-being. One way to minimize anthropogenic impacts on the environment is through scientific inquiry and informed planning.

In the United States, the planning process occurs at the local level. Although most laws and regulations, such as environmental protection (CEQA—California Environmental Quality Act) and source water protection (Clean Water Act, Safe Drinking Water Act), are made at State and Federal levels, local planning happens on Tuesday nights at City Council and County Board of Supervisor meetings scattered throughout 478 cities and 58 counties across California (Fulton and Shigley 2005). All too often, the result of this system is inconsistent planning across jurisdictional boundaries and lack of regionally coordinated efforts. The cumulative effects of multi-jurisdictional decisions are rarely considered in any one decision. Conceptualizing the effects of individual decisions on regional resources is difficult without the aid of analytical tools seldom available to local decision makers.

One approach to quantifying the magnitude and nature of the impacts of population growth on existing regional resources is to use an urban growth model implemented in a geographic information system (GIS) and the output to assess the ecological impacts of the projected future growth. One example of this approach involved four growth scenarios developed for the San Joaquin Valley using a cellular automata model called SLEUTH (Teitz 2005) to model growth distributions. Another example is the Partnership in Integrated Planning Process implemented in Merced County, California (Smith et al. 2004) where the community interacted with modelers to create scenarios that reflected the community's perceived range of options.

Our approach was to use UPlan, an urban growth allocation model developed by Professor Robert Johnston and others at UC Davis (Johnston et al. 2006). UPlan has been used for several growth modeling projects, including the Partnership in Integrated Planning process in Merced County (Smith et al. 2004) and, more recently, the San Joaquin Valley Blueprint process

(The Great Valley Center 2006). We also chose to use a process of “community” participation in building the model by having Partnership subcommittee members take part in the creation of the scenarios to be modeled.

This paper describes each of seven different growth scenarios developed interactively with the Partnership’s LUHA committee, and then provides an analysis of the potential impacts of the different scenarios on the region’s environmental resources (e.g. natural vegetation, endangered species, habitat connectivity, wildlife corridors, and natural landscapes). We also review the policy recommendations in the Strategic Action Proposal adopted in October 2006 by the Governor’s Partnership for the San Joaquin Valley (Department of Business Transportation and Housing 2006).

From a policy perspective, the Partnership for the San Joaquin Valley provides an excellent example of coordinated local planning. The members of the Partnership come from local City Councils and Boards of Supervisors from the eight counties; they are *local* decision makers. Rather than the typical case of individual cities and counties planning land use policy independently, this group coordinated and developed consensus through a series of meetings and produced joint recommendations for the region. Because the Partnership was initiated by an executive order, the State has also played a key role. As a result of the Partnership’s efforts, California has allocated 2.5 million dollars in seed money for the first year for projects aimed at fulfilling the Partnership’s recommendations (Department of Business Transportation and Housing 2006).

This paper focuses on limitations of the Partnership’s report as it relates to natural resource conservation and biological resource protection. It also demonstrates the value of the UPlan model for testing different policy scenarios and quantifying the potential impacts of each proposed scenario on the San Joaquin Valley’s remaining valuable natural resources.

## III. Study Area

The San Joaquin Valley of California (Figure 1) includes eight counties and occupies about 17.5 million acres of land (approximately 27,500 square miles). It is a geographically and biologically diverse region with rich natural resources. During pre-European settlement times, the valley floor was well connected to the foothills and mountains through natural community linkages, and thus constituted a healthy, functioning ecosystem (Meade and McCoy 2006). During the late nineteenth and early twentieth centuries, the San Joaquin Valley became one of the most productive agricultural centers in the country. For many decades it was known strictly as an agricultural center, but as housing and population pressures in the coastal regions of California have increased, the population of the San Joaquin Valley region has started to increase and the pressures on its resources have intensified. In the next 35 to 40 years, the population of the San Joaquin Valley is expected to more than double, increasing from 3.3 million today to more than 7 million by 2040 (Teitz 2005), and by 2050 there are likely to be close to 8 million San Joaquin Valley residents (Table 1) .

This region, which is currently growing faster than Mexico (Central Intelligence Agency 2002) and has a poverty rate higher than Appalachia (Rural Migration News 2006), will need to accommodate this predicted growth, but how it will do so is still left to be decided. Needless to say, the region faces many challenges in the coming decades. Some interesting statistics about the region in comparison to the rest of the state of California include the following (Department of Business Transportation and Housing 2006):

- Average per capita incomes are 32.2% lower than the rest of California.
- College attendance is 50% below the state average.
- Violent crime is 24% higher.
- Access to healthcare is 31% lower.
- Air quality is among the worst in the nation.

Clearly the human resources and agricultural productivity of the San Joaquin Valley make this a region of vast importance to the State of California and to the rest of the nation, and yet the San Joaquin Valley faces serious challenges as the region braces for a period of rapid growth. Now is the time to plan for that growth in a way that benefits both humans and their environment.

**Figure 1: The San Joaquin Valley of California includes eight counties in the southern part of the Central Valley.** The green (thick) outline represents the boundary used by the San Joaquin Valley Partnership's Land Use, Housing and Agriculture (LUHA) Work Group and for all analyses described in this paper.

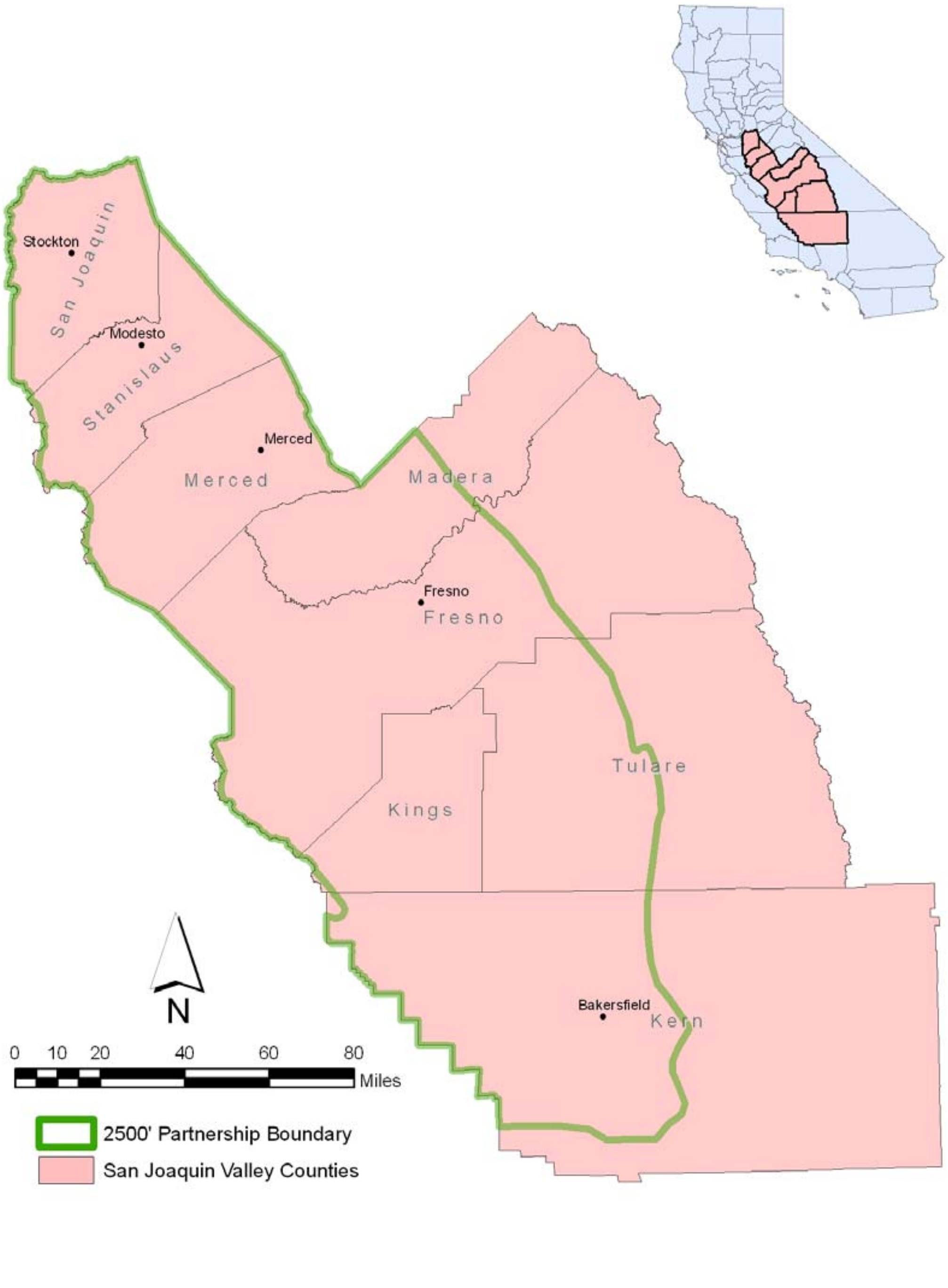

**Table 1: San Joaquin Valley Population in base year (2000) and future year (2050) for each of the eight counties (Department of Finance 2004).** These values were used for population growth predictions in the UPlan model.

| County | 2000 | 2050 |
|---|---|---|
| San Joaquin | 567,798 | 1,707,599 |
| Stanislaus | 449,777 | 941,562 |
| Merced | 210,876 | 625,313 |
| Madera | 124,372 | 302,859 |
| Fresno | 803,401 | 16,58,281 |
| Tulare | 369,355 | 867,482 |
| Kings | 129,823 | 282,364 |
| Kern | 664,694 | 1,549,594 |

## IV. Implications of the Partnership's Strategic Action Proposal on Environmental Factors

The importance of regional planning was recognized in the San Joaquin Valley (SJV) over a decade ago. The San Joaquin Valley Air Quality Management District (SJVAQMD), created in 1992, was the first governmental agency to specifically address the Valley as one region (Partnership for the San Joaquin Valley 2006). Recognition of the regional nature of air quality problems led to the formation of the SJVAQMD. In 1998, the Great Valley Center began a series of conferences and studies that statistically documented and facilitated regional conversations on a number of economic, social and environmental issues. These activities led to the Highway 99 Task Force, a public/private working group that brought together varied interests from across jurisdictional lines to promote improvement of the Valley's main transportation corridor (Partnership for the San Joaquin Valley 2006).

The next significant coordinated planning effort in the SJV came in response to the growing population pressures. In June 2005, Governor Arnold Schwarzenegger formed the California Partnership for the San Joaquin Valley (Partnership) to "…improve the economic well-being of the Valley and the quality of life of its residents" (Department of Business Transportation and Housing 2006). This 26-member Partnership, led by the Secretary of the Business, Transportation and Housing Agency, was composed of eight state government members (primarily cabinet level appointees), eight local government members (primarily members of county boards of supervisor) and eight private sector members (primarily representing leadership in a variety of business sectors). The region of focus for the Partnership included San Joaquin, Stanislaus, Merced, Madera, Fresno, Tulare, Kings, and Kern Counties. The Partnership delivered a San Joaquin Valley Strategic Action Proposal to the Governor in October 2006 that provides a framework for action and a foundation for future investment meant to improve the economic prosperity of life for the San Joaquin Valley (Department of Business Transportation and Housing 2006).

The vision of the Partnership, as indicated in their October 2006 report to the Governor (Department of Business Transportation and Housing 2006), is for the SJV to be a "cohesive region composed of unique communities and a diverse population that is supported by a vibrant economy built on competitive strengths and sufficient resources to provide a high quality of life for all residents now and in the future." This vision, according to the report, can best be achieved through public-private collaboration. Such a partnership would provide a coherent strategy that commits immediate and sustained leadership to accomplishing specific objectives. The Partnership's report further suggests that "…this vision will be achieved through coordinated actions to achieve a Prosperous Economy, Quality Environment, and Social Equity—the "3Es" of sustainable growth." Although environmental quality was identified as an integral component, it was not included in the Partnership's final recommendations. The Partnership's report focused almost entirely on economic conditions and impacts rather than considering population growth impacts on the region's remaining biological and other natural resources. Its recommendations were the following:

1. Grow a diversified, globally-competitive economy supported by a highly-skilled workforce.
2. Create a model K-12 public education system.
3. Implement an integrated framework for sustainable growth.
4. Build a 21st century transportation mobility system.
5. Attain clean air standards.
6. Develop high-quality health and human services.

Although preservation of the environment and natural resources was not extensively addressed in the Partnership's overall recommendations, the Partnership's LUHA Work Group's recommendations did include identification of "… important natural resources and agricultural lands so they can be protected from the adverse impacts of urbanization" (Partnership for the San Joaquin Valley 2006). This Work Group was given the task of creating a strategy and recommendations to accommodate growth that would ensure the viability of agriculture and the sustainability of the region's natural resources during the coming decades of growth and change (Partnership for the San Joaquin Valley 2006). The strategy and recommendations were passed on to the eight-county SJV Blueprint Planning Process (The Great Valley Center 2006) , a regional visioning collaborative consisting of the Councils of Governments of the same counties forming the Partnership.

In addition to the LUHA Work Group report, a subcommittee of the LUHA Work Group wrote a report titled "Identifying High Value Open Space and Conservation Opportunities in the San Joaquin Valley" (Meade and McCoy 2006). This report identified approaches to preservation of high value open spaces, identification of natural resource protection opportunities, and methods for nominating areas for protection in the SJV (Partnership for the San Joaquin Valley 2006). Included in the Meade and McCoy report was a "Potential High Value Conservation Opportunities" diagram that combined biological and natural resource data for the eight-county region. Using GIS, the fourteen biological components representing natural communities and biological diversity were overlaid (combined) into a single layer. Places on the resultant diagram that featured concentrations of these priority conservation targets (as identified by the range of participants in this planning process) implied locations of high conservation opportunity. The purpose of the diagram was to help focus conservation efforts toward those locations that are most critical to the future ecological well-being of the region. The diagram represented the best available data for the region as well as input from key natural resource agencies and departments and the leading conservation NGO's active in the region. All of the major natural systems in the region were afforded substantial recognition in a landscape scale analysis that included large reserves interconnected with functional natural corridors.

The mapped results of this process and analysis were filtered out when information was submitted up the chain (from the LUHA Work Group report to the Partnership report). The LUHA report suggested that the recommendations given by the Partnership to the Governor should have included a strong natural resource protection element. The only reflection of the importance of these resources in the recommendations was in the recommendation that the region "Implement an integrated framework for sustainable growth" and that the region "Attain clean air standards"  A favorable interpretation of these recommendations may give some recognition of natural resource conservation values but they are not addressed directly.

However, it is clear that land use policy choices will ultimately determine the distribution of growth in the region and that urban growth will have marked effects on natural resources. We recommend that the projected environmental impacts under the seven different urban growth scenarios be re-integrated into the overall planning framework for the SJV.

## V. UPlan Growth Model, Scenario Development, and Impacts on the Environment

### A. The UPlan Model

In early 2006, the Partnership's LUHA Work Group requested that ICE implement several potential growth scenarios based on different growth policies defined by the Work Group.  The parameters associated with each scenario were developed in a collaborative process during several LUHA meetings at the Great Valley Center in Modesto.  ICE implemented these scenarios using the GIS-based urban growth model, UPlan, that Robert Johnston created several years earlier (Information Center for the Environment 2006) and that ICE recently enhanced.

UPlan projects spatially explicit urban growth patterns in several land categories.  Four residential, one industrial, and two commercial densities are represented.  The model does not calibrate based on historical data because its intended use is for long-range scenario testing.  It relies on fine-grained raster data (the cell size may be determined by the user) that represent existing urban, local general land use plans, and all other relevant natural and built features that define the model.  It is deterministic and rule-based, so as to be transparent to the user.  The urban growth allocation rules broadly simulate land markets.  The model is free to the public and can be applied to counties, metropolitan regions, watersheds, and bioregions.  UPlan allocates growth to different cells using attractors that encourage growth and discouragements that discourage growth.

Some assumptions of UPlan are the following:

- Population growth can be converted into demand for land use by applying conversion factors to employment and households.
- New urban expansion will conform to city and county general plans.

- Cells have different attraction weights because of accessibility to transportation and infrastructure.

- Some cells, such as lakes and streams, will not be developed. Other cells, such as sensitive habitats and floodplains, will discourage new development.

UPlan is easy to use and informative for planners and citizen groups alike (Johnston et al. 2006). UPlan users can change the assumed growth rates or other basic assumptions and can set various environmental and social attractors and constraints to growth such the built environment, sensitive habitat, or agricultural lands (Smith et al. 2004). UPlan has been used for several applications during the past few years, including modeling urban buildout along California's highways (Thorne et al. 2006), transportation planning (Johnston et al. 2003), and modeling future development in California's Sonoma County (Merenlender et al. 2005).

For all seven scenarios described, we applied the following set of parameters:

<u>Growth Attractors :</u>

- US Census Blocks with Growth 1990-2000
- Major Arterials
- Minor Arterials
- Highways (not using ramps)
- Freeway Ramps
- Spheres of Influence

<u>Growth Discouragements:</u>

- The Nature Conservancy Priority Conservation Areas
- Vernal Pools (Holland)
- FEMA Q3 Floodplains
- Natural Diversity Database records

<u>Areas Masked from New Growth:</u>

- Existing Urban (Derived from Department of Conservation's Farmland Mapping and Monitoring Program)
- Streams 100m buffer
- Lakes 100m buffer
- Public Land

Where additional Attractors, Discouragements, or Masks were applied, these are indicated in the specific scenario descriptions in the next section. The growth projection numbers used for all scenarios in the model came from the Department of Finance for the year 2050

(Department of Finance 2004). Inputs were derived from easily accessible and publicly recognized data sources such as the US Census, California Department of Finance, California Department of Conservation, California Department of Transportation, California Resources Agency and University of California, Davis spatial and demographic data libraries.

## B. UPlan Methods for SJV modeling

### 1. UPlan Scenarios

We used UPlan to analyze the potential effects of seven different urban growth scenarios on the 14 environmental data layers. Descriptions of the basic goals of each scenario, as described in the ICE metadata for the output GIS layers for each scenario run, are indicated below.

1. **Status Quo Scenario—**Industry, Commercial High, Commercial Low, Residential High and Residential Medium were allowed to go into agriculture. Residential Low and Residential Very Low were also allowed to go into agriculture if all growth could not be allocated within the current general plans. This model run showed a possible outcome if no significant changes are made to urban growth policies through 2050. This run was used to provide a baseline against which other models can be compared.
2. **East/West Road Improvement Scenario—**Inputs and allocation rules were the same as Scenario 1 except the East/West roads of interest (I-580, 205, Highway 4, 12, 58, 140, 152) were given double weight as attractors to growth. The East/West Road Improvement model run showed a possible outcome if growth is encouraged along seven existing major East/West roads. This run modeled a policy of improving the infrastructure along these already existing highways.
3. **Compact Growth Scenario—** Inputs were the same as Scenario 1 except Residential Low (RL) and Residential Very Low (RVL) were eliminated and their population was added to Residential Medium (RM). All growth was allocated within current Spheres Of Influence (SOI). If the needed growth was under-allocated then RM housing density was increased to accommodate

the growth within existing SOI's. Increased density was necessary in all counties except Kings. In some cases the development could not be sustained entirely in the RM category without dropping RM below 0.1 acre per dwelling unit. When this occurred the development pattern was shifted to 33% RH and 67% RM. These changes were needed in San Joaquin, Merced and Stanislaus counties. This run modeled a policy of very compact growth where increased population is accommodated by increasing densities rather than modifying boundaries and building outside the existing SOIs.

4. **Farmland Protection Scenario—**Prime farmland and farmland of statewide importance were used as a mask. All other variables were the same as Scenario 1. In Fresno County, Commercial Low and Residential Medium were allowed to go into Residential Low, Residential Very Low and agricultural land. This run modeled a policy of protecting particularly high-valued farmland as a top priority and required all growth to be allocated outside of these designated areas.
5. **I-5 to Highway 99 Exclusion Scenario—**The area between I-5 and Highway 99 was used as a mask. All other variables were the same as Scenario 1. This run modeled a policy of restricting all new growth to occur to the west of I-5 and to the east of Highway 99. Such a policy would protect a great deal of existing prime farmland and would encourage growth on either side of these major roadways (but not between them).
6. **New Cities Scenario—**Four new cities with populations of approximately 250,000 were created in areas of relatively low agricultural and environmental importance near significant entry points to the SJV. Residential densities were increased by 15% for all classes except Residential Very Low, which was eliminated. Population from the Residential Very Low class was added to the Residential Low class resulting in a net increase in Residential Low area occupied despite the increased density. This run modeled a policy of creating new cities in areas that do not have high farmland or biological value. Such a policy would focus growth in compact areas by creating four new urban centers.

7. **Great Cities Scenario—**Existing major cities were encouraged to grow to house the predicted population growth. Residential densities were increased by 15% for all classes except Residential Very Low which was eliminated. Population from the Residential Very Low class was added to the Residential Low class resulting in a net increase in Residential Low area occupied despite the increased density. This run modeled a policy of creating two or three new "megalopolis" areas of over one million inhabitants. Such a policy would promote growth immediately surrounding existing urban centers.

We ran the UPlan model for each of the seven scenarios. The different emphasis of each scenario reflected different potential growth policies. Results from each Uplan model run were in raster format by county. These were merged into one regional layer (all eight counties) for each run and were converted back to a vector layer.

## 2. Biological Resource Data Layers Used

ICE used a series of GIS data layers to develop the set of conservation opportunity areas for the California Partnership for the SJV. These areas featured concentrations of priority conservation targets as identified by a group of natural resource professionals during the planning process. The areas were meant to help focus conservation efforts towards those locations that are most critical to the future ecological well-being of the region.

The first step in the process of the ecological data set creation was to hold a series of meetings involving a wide range of natural resource planners representing federal, state, local, and private agencies and organizations. These attendees identified fourteen key conservation priorities in the SJV (Meade and McCoy 2006):

- desert scrub (CA GAP Analysis Project)
- blue oak woodland (CA GAP Analysis Project)
- sensitive ecological communities (CA Natural Diversity Database)
- Grasslands Ecological Area (Central Valley Habitat Joint Venture)
- historic lakebeds (Endangered Species Recovery Program)
- kit fox habitat (intersection of CA Natural Diversity Database kit fox locations with Endangered Species Recovery Program annual grassland and desert scrub polygons)

- buffers around existing conservation areas (Public/Conservation Trust Lands buffered 2 km)
- 100-year floodplain (FEMA Q3 flood data)
- riparian corridors (500 m buffers around named rivers from National Hydrography Dataset)
- perennial grassland (CA GAP Analysis Project)
- Tehachapi corridor (Endangered Species Recovery Program natural land cover polygons between I-5 and Hwy 58)
- high concentrations of sensitive species (CA Natural Diversity Database—A compiled density of threatened and endangered species built around 2000-meter wide hexagonal cells. The dataset was created by generating a blank hexagon grid, intersecting it with the May 2005 CNDDB dataset, and then counting the number if unique species from the CNDDB within each hexagon cell. All hexagons with at least four sensitive species occurrences were used in the analysis)
- vernal pool complexes in Stanislaus, Merced, Madera, and Fresno Counties (U.S. Fish and Wildlife Service)
- Tulare Basin planning areas (Tulare Basin Wildlife Partners)

The LUHA Work Group subcommittee (led by Rod Meade) obtained these priority data in (or converted them into) GIS layers and overlaid them to determine those locations of densest concentrations. The map extent used for these layers, shown in Figure 1, included all areas in the eight San Joaquin Valley counties up to 2,500 feet in elevation (for a total of 16,736 square miles). This analysis does not include data beyond this boundary. The "Potential High Value Conservation Opportunities" diagram ((Meade and McCoy 2006) was the result of combining all the data layers together and coding each resultant polygon with a value for how many of the 14 biological layers fell within that polygon. Those polygons with the higher values will potentially represent areas of higher conservation priority as the SJV population grows and planners decide where and how this growth will be allocated. We performed a different analysis, in contrast to the Meade and McCoy (2006) analysis. Meade and McCoy treated multi-species, multi-habitat "opportunities" that attempt to capture as much of the individual resource variance as possible.

### 3. Combining UPlan Scenario Outputs with the Biological Resource Layers

Our final step was to combine the output from the seven growth scenarios with each of the fourteen biological resource layers. Each of the seven region-wide scenario outputs was overlaid using ESRI's ArcEditor version 9.2 (Environmental Systems Research Institute) with each of the fourteen conservation priorities layers. The total acreage of each resource that would be converted to human use (including residential, industrial, and commercial uses) was calculated, summarized, and displayed.

These fourteen biological factors represent key conservation priorities selected by a group of professional natural resource planners representing federal, state, local, and private agencies and organizations (Meade and McCoy 2006). The goal of this analysis was to identify which scenarios, if implemented, would have the least negative impact on each of these resources in the SJV.

## C. Findings

Depending on the scenario chosen (and hence the policy emphasis), the number of acres of biological resources likely to be lost due to growth varied significantly. The results of this analysis are shown in Table 2. The scenario with the overall least amount of impact is the Compact Scenario (Scenario 3), with Scenarios 6 (New Cities) and 7 (Great Cities) also fairly low in relative impact. Scenarios 1 (Status Quo) and 2 (East/West Road Improvement) showed higher overall environmental consequences, while Scenarios 4 (Prime Farmland Protection) and 5 (Between I-5 and Highway 99 Exclusion) resulted in the largest decline in the acreage of the fourteen biological resources data layers we examined.

**Table 2: Relative effects on SJV environmental resources for each of the seven growth scenarios modeled.**

| Scenario | Development Strategy | Loss of Environmental Resources |
|---|---|---|
| 1. Status Quo | No significant change in land use | High |
| 2. East-West Roads | Encourage growth on East West roads (I-580-205, Hwy 4,12, 58, 140, 152) | High |
| 3. Compact Growth | Develop high density residential growth around current spheres of influence | Lowest |
| 4. Prime Farmland Protection | Preserve farmland and designate growth outside farm areas | Highest |
| 5. Exclusion Area | Preserve areas between I-5 and Hwy 99 from development | High |
| 6. New Cities | Create four new small cities of 250,000 near SJV portals on land with low biological value | Low |
| 7. Great Cities | Expand existing cities to 1 million plus with high density residential development | Low |

## D. Discussion of Findings

The results of this analysis indicate that Scenario 3 (Compact Growth) is the best strategy for minimizing the overall effect on biological resources while accommodating growth during the coming four decades. We are not suggesting that the Compact Scenario be adopted as is without other factors considered. We do recommend accommodation of a large portion of projected growth in high density residential areas that remain, as much as possible, within the footprint of existing towns and cities. We recommend encouraging growth immediately adjacent to and within existing large urban areas and creating "Great Cities" (Scenario 7) and/or considering the development of new cities (Scenario 6) rather than permitting urban and exurban sprawl. These three strategies provide for the projected growth and result in less impact to the region's precious biological resources.

## VI. Conclusion

This paper provides guidance for planners held responsible for the future footprint of human settlement in the region. The San Joaquin Valley of California is one of the fastest growing regions in the country. With staggering projected growth rates for the region, intelligent planning is essential if limited, valuable resources are to be preserved for future generations. The methods presented here may also become a useful template for examining possible outcomes of growth strategies and assessing regional planning in other parts of the state.

## VII. Acknowledgments

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