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INTEGRATING CONSERVATION AND LONG-RANGE TRANSPORTATION PLANNING USING A STRATEGIC ASSESSMENT FRAMEWORK

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Abstract

The Pikes Peak Area Council of Governments *Moving Forward* metropolitan transportation planning process introduced a Strategic assessment planning framework to the Pikes Peak region. This framework was selected because it integrates multi-disciplinary qualitative and quantitative information from technical experts and regional stakeholders to determine and weight objectives and indicators within the evaluation process. In order to implement this framework the regional modeling system was updated and several new technical tools added; including Natureserve's *Vista* for habitat conservation, and Placeways' *CommunityViz* for community impact evaluation. PPACG received funding from the FHWA to investigate integration and initial application of these planning tools at the regional level.

Both the biological impacts of potential transportation investments and potential locations of regional mitigation sites were determined by integrating conservation planning concepts, planned land uses, and transportation planning concepts using *Vista* software. A matrix was created to describe the compatibility of each conservation species (selected to represent a larger conservation objective) with each land use class. The analyses found that, given current urban development, there should already be serious concerns about the long-term viability of some species and that some rare and imperiled species face significant threats from planned developments. The initial output was reviewed and refined by Colorado Natural Heritage Program ecologists in order to map ecologically relevant areas of conservation importance. This information was then incorporated in the *CommunityViz* growth scenarios. Several future socio-economic scenarios and their respective conditions were developed.

The analyses in *CommunityViz* showed two key factors in the growth and development pattern of the study area. First, it showed that increasing density to support an increased transit system can concentrate growth around transportation corridors meeting or approaching transportation, social and economic goals from public input within the timeframe of the long-range plan. It also showed that a conservation plan could be applied in conjunction with this transit-oriented development to achieve publicly stated conservation goals. Combining transportation and conservation planning could successfully focus development around city centers while relieving development pressure on land that is necessary to meet conservation goals.

The best scoring alternative was not adopted by the elected leaders in the region due to its dependence on changed land uses. The reason for this is that land uses are outside the purview of MPO. However, several smaller projects resulted from the enhanced communication, including the CDOT and the Colorado Springs Stormwater Enterprise each moving water quality mitigation project locations to co-locate with a developer's project. This mitigation effort will create more total ecological benefit and an additional cultural amenity.

The primary outcome of the PPACG process is that both citizens and decision-makers are better informed regarding the tradeoffs between transportation investment decisions and other planning and development decisions that were previously made in isolation.

Introduction

Several trends are currently changing the nature of planning in the U.S. Both federal policies and requirements and input from local citizens and elected officials reflect these trends (Dietz, 2008), which include:

1. Integrating issues from traditionally separate fields, such as conservation and transportation, when making decisions;
2. Increasing public input and consider the needs and desires of all potentially affected interests in plans;
3. Increasing the use of enhanced technical planning tools to improve the performance of investments.

To increase confidence in the planning process, planners need a decision-making framework for complex multi-criteria problems that can accommodate both qualitative and quantitative information from disparate sources and of different resolutions and formats. A solution explored by the Pikes Peak Area Council of Governments (PPACG) is using a strategic assessment planning framework that is a cross between traditional NEPA analysis and integrated regional planning. This process incorporates multi-criteria analysis (MCA) that is typically used in conservation planning (Mendoza, 2004). A precautionary note: the MCA process rarely results in community consensus due to broadly perceived needs, priorities and impact distribution. It can, and in PPACG's case did, lead to informed consent for the decisions that were made. The difference between consensus and consent is that groups that were involved in the process, but did not agree with the outcomes, did agree to not actively work against implementation of the recommendations.

Inherent in this framework is the need for technical tools that provide more and better information to decision-makers on the needs, deficiencies, and trade-offs between alternative programs, projects, and service investments within a region. While many tools can do similar functions, for this effort the PPACG and the Colorado Natural Heritage Program (CNHP) used NatureServe's decision-support software, *Vista*, to conduct initial conservation planning iteratively with growth and development scenarios created via Placeways' community planning software, *CommunityViz*.

Vista integrates conservation information with land-use patterns and policies, enabling users to create plans and policies and assess their impacts on natural resource goals. With the use of its ArcGIS extension software, *CommunityViz*, stakeholders, government agencies, and community members can better communicate and understand the outcomes of a proposed project or future growth and development in a region. These tools also have the advantage that they have history of being able to communicate and work iteratively with each other.

Planning Framework

While a well-designed and executed planning framework may not eliminate conflicts, it can enhance collaboration and pinpoint areas of and reasons for conflict between different planning efforts (transportation, land-use, conservation, economic development, etc.) to further shape and refine alternatives and relationships. In order to accomplish this, procedures were undertaken to ensure the transportation planning framework was:

1. Legitimate: The process actively reached out and was accessible to all potentially affected interests.
2. Rigorous: The process did not allow those who voiced their concerns most loudly, most often, or most articulately to wield disproportionate influence. Instead, the impacts and alternatives were evaluated using scientific standards for data and analysis so that competing claims were assessed fairly.
3. Timely: The complexity of decision-making can lead to very lengthy deliberative processes. There was a need to expedite decision-making and avoid 'analysis paralysis.'

In the current planning climate, with complex and often contradictory goals prioritized by the public, decisions need to consider useful scientifically based analysis of the social, economic, and ecological consequences of investments. Confusion and suspicion can arise if a logical and well-structured decision-making process is not used to analyze and rank projects with these considerations (Dietz, 2008). This makes technical analysis more than a backroom exercise; it is inseparable from the decision-making process and must be transparent and accessible. The PPACG transportation team refined the standard transportation planning framework and used a strategic assessment framework based upon soliciting and synthesizing data and input from both citizens and technical experts from multiple disciplines to determine considerations that can inform decision-making (Mendoza, 2004).

In situations such as transportation planning, where the analysis and decisions made may be subject to later legal challenge, the ability to communicate and document how the decisions were reached is as important as the decisions themselves. A rigorous strategic assessment separates the decision elements and communicates both how the decision-making process evolved and what the result was, making it ideally suited to regional decision-making. Proper documentation of both the technical and public communication processes, the information used, and the results of

each step ensure that information developed and decisions made during planning are useful and useable during NEPA studies and can be carried into the NEPA process.

When the term "decision-making" is used in planning, it generally refers to the final approval of a policy or plan. However, in the strategic assessment framework used by PPACG, both public and agency input is included in making the small decisions on which assumptions and information will be based to develop the larger analyses that are then provided to decision-makers. This process ensures that there is opportunity for the public and agencies to remain in step with the regional transportation planning process (Mendoza 2004).

Steps of the PPACG Framework

The following steps are generally listed in the order in which they occur. However, most steps are iterative as the planning process progresses.

Step 1: Establish the Foundation for Decision Making

The following transportation planning principles adopted by PPACG reflect the region's goals for its transportation system (in no particular order):

1. Preserve the existing transportation system.
2. Provide efficient transportation for people and goods.
3. Develop a multi-modal transportation system that provides access to employment, services, military installations, and other destinations.
4. Fully integrate connections within and between modes for people and for freight.
5. Increase the safety of motorized and non-motorized travel.
6. Increase the security of the multi-modal transportation system.
7. Support the economic vitality of the Pikes Peak area.
8. Improve mobility of people and goods.
9. Protect and enhance the environment by implementing transportation solutions that are sensitive to natural and human contexts.

Step 2: Determine Public and Agency Concerns and Desires

In order to continue to provide transportation customers with a system that they are willing to purchase, it is necessary to identify and incorporate their desires into investments in the system. An added regional and national goal is to consider how transportation fits within the surrounding natural and human contexts. The issues, measures, and opportunities that make up the regional context should be identified early in the planning process. This regional context encompasses transportation-related social, economic, and ecological values and issues, and the role of non-transportation agencies in the transportation planning process. Most importantly, the process requires the involvement of citizens who have a stake in the transportation system as customers, investors, and those whose quality of life will be impacted by the decisions made. The development and prioritization of issue areas was made with awareness of legal requirements and the social, economic, and ecological goals, policies, and plans of other agencies that can impact or be impacted by transportation investments.

PPACG utilized several public involvement techniques to provide a development process that is open and promotes transparency and accountability, along with establishing a solid foundation for subsequent stages of development and refinement. The specific techniques include:

1. PPACG Advisory Committees: The regular meetings of these committees and the PPACG Board are open to the public.
2. PPACG Public Participation Working Group: Supplemented the advisory committee structure and facilitated two-way communication with key stakeholders and agencies in the region.
3. Speaker's Bureau: An active outreach effort that targeted civic and community organizations, including economic development groups and homeowners associations.
4. Focus Groups: An interactive method conducted at critical milestones to gain understanding of perceptions, concerns, and knowledge about key issues. The three focus groups used by PPACG were statistically valid representations of the region based on race, income, sex, age, and geography.
5. Elected Official Briefings: Offered information on the status of the process so that the officials are able to answer questions from their constituency. These briefings occurred during PPACG Board of Directors' meetings and at the member entity council, commission or board meetings.

6. Public Fairs/Special Events: Information was provided to the public during various community events, such as farmers markets, street fairs, home and garden shows, and during community celebrations. A "traveling display" was assembled. A rating and ranking activity and short survey forms that individuals can complete quickly were administered / used.
7. Facilitated Workshops: Provided education and solicited input through facilitated sessions. As with the focus groups, they provide a mechanism for a higher level of participation in the planning process. PPACG conducted two Regional Transportation Roundtables that included a "game" where participants invested fiscally constrained funds using lifecycle cost effectiveness by specific project mode and location.
8. Open House Meetings: This format for general public meetings offers another means to enhance two-way communication by talking with citizens one-on-one and soliciting their input on the planning process. Information stations with displays and other supporting materials can be used and comment forms made available.
9. Final Public Hearing: Formally presented the recommended plan to the public in its entirety (following recommendations by the appropriate PPACG Committees and public input).

Step 3: Develop and Prioritize Decision-Relevant Measures of Effectiveness

Developing and prioritizing principles of and determining how to measure progress or impact requires the participation of many stakeholders fulfilling their roles as technical experts, policy analysts, and decision-makers. This step also provides additional opportunities for public and agency participation. At this stage the public can identify key issues and information needs that they hope or are concerned will be changed by transportation investments. Providing an open process also promotes transparency and accountability. Coordination with other planning agencies highlighted additional considerations that are traditionally considered during the project implementation process but could benefit by inclusion in the long-range transportation planning process, such as location of species or water quality issues. By weighting the principles, the region determined the relative importance of one issue against another in order to develop a regionally customized approach to balancing issues and concerns (Casper, 2006).

PPACG used a simple three-step methodology to determine the analysis that will be utilized during the long-range transportation plan development:

1. Compiled a "long list" of all concerns expressed either from data or from information provided by agencies and the community. Concerns were not excluded or pre-judged as to their relevance, value, or validity.
2. Presented the comments to PPACG's Board of Directors who created the following "short list" of key issues:
    a. Pavement Condition
    b. Bridge Condition
    c. Efficient (Uncongested) Intersections
    d. Increased Travel Choices
    e. Safer Travel
    f. Reduced Social Impacts
    g. Reduced Natural Impacts
    h. Reduced Pollutant Emission
    i. Effective Freight Movement
3. Classified and ordered the key issues into "impact categories" for inclusion in the decision-making process.

Step 4: Gather Baseline Conditions

Effective evaluation of the severity, extent, duration, and likelihood of impacts from transportation investments requires reliable information on the current state of the social, economic, and ecological environments. Baseline information plays an important role in informing planners, decision-makers, and the public about the nature and scale of current issues. It provides an essential reference point against which to predict and monitor the outcomes of different transportation investments. However, gathering baseline information is time-consuming and expensive, particularly if field monitoring is necessary to acquire new data. The PPACG transportation team obtained data from agencies or from previous feasibility and/or environmental studies of various projects around the region.

Based on an on-going appraisal of data availability and quality, future efforts may be needed to collect new or additional data for the evaluation process based on evolving knowledge of impacts and the likelihood of impact occurrence. This adaptive effort was and will be guided by previous studies and local knowledge to identify data deficiencies and needs.

Step 5: Forecast Potential Development Futures

A well-executed analysis of options is vital to the outcome of the process. This requires development of several regional modeling systems that can provide useful forecast and evaluation of identified issues from Steps 2 and 3. PPACG utilized Natureserve's *Vista* and Placeways' *CommunityViz* for the bulk of this step, developing two initial scenarios: "Business as Usual" and "Enhanced Transportation", which is an in-fill-focused scenario.

A major issue with this step was educating transportation and other agency technical staff, decision-makers, and the public on the analytical limitations of the various models and evaluation systems and convincing them that a solution to uncertainty is use of scenarios. Prediction and evaluation methods often involve a degree of uncertainty, particularly where information is limited and environmental impacts are difficult to predict. A good technical process will include uncertainty and adopt a precautionary approach to decision-making while still enabling consideration of the broader and more complex issues and interactions such as land use and environmental (social, economic, and ecological) protection.

The complexity of the land development process, evolving travel decisions, rapidly changing forms of industry and commerce, a swiftly shifting population structure, changing lifestyles, increasing motor vehicle fuel costs, and alteration in the value of time, means that even a perfect set of forecasting models will not eliminate uncertainty. As a result, it was necessary to achieve some level of agreement on what constitutes useful measures of effectiveness and evaluation. The PPACG transportation team chose to combine input from committees and other interested parties to develop several scenarios instead of trying achieve a single perfectly accurate forecast. Awareness of what the purpose of each scenario was allowed erring on the side of caution and better bracketing of the analyses.

> *The point is not so much to have one scenario that 'gets it right', as to have a set of scenarios that illuminate the major forces driving the system, their interrelationships and the critical uncertainties.*
> Peter Wack *(1985)*

Step 6: Create Transportation Investment Scenarios

PPACG began to develop five general transportation investment philosophies, listed below, that would then be consolidated into idealized future systems based on coherent philosophies relayed during the public and agency involvement process. Total costs and effectiveness of the different systems were to be evaluated. Ideally, the combination of these scenarios would have painted a picture of the total regional transportation vision and needs. Additionally, from these vision systems, a fiscally constrained subset of transportation system improvements would be derived to include in the Regional Transportation Plan. The lengthened time of the analyses and public discontent with some concepts interrupted these planned processes.

1. Provide Maintenance Only: What is the cost to maintain the current conditions or achieve desired conditions? This analysis showed approximately $2 billion in existing backlog of maintenance needs increasing to $7 billion in maintenance needs by Year 2035.
2. Management and Operational Improvements Only: What effect could be realized with transportation system management strategies, including advanced technological improvements and coordination, and at what cost? This concept was only generally explored during this plan update.
3. Free Flowing Roads: What is the total cost to not have any roads with a volume-to-capacity (V/C) ratio over 1.0? After showing the public examples of four-lane roads that needed to be expanded to ten lanes and two-lanes that needed to be increased to six, this option was abandoned.
4. High Quality Public Transportation: What transit system can be implemented for the same cost as free-flow roads and what is its effectiveness? This analysis showed that we could quadruple bus service and implement four bus rapid transit routes and commuter rail along the Front Range.
5. Non-motorized Dominant: What is the cost to fully implement a trails and "complete streets"-type system? The greatest disparity between planned/needed facilities and available funding was for non-motorized system improvements. Funding would need to increase by an order of magnitude to make measureable progress in implementing this system.

The three transportation investment scenarios that were developed and evaluated were:

1. Strategic System Investment: A continuation of existing road-centric investment practices.
2. Environmentally Least Damaging: Maintenance of existing roads and bridges, improving operational characteristics of the roads, and construction of transit and non-motorized facilities.
3. Balanced Investment: Seeks a middle ground between the other scenarios.

Step 7: Evaluate and Refine Scenarios

The 2035 Regional Transportation Plan used Multi-Criteria Analysis (MCA) to analyze projects and scenarios. MCA is an analysis tool developed for complex multi-criteria problems that include both qualitative and quantitative information in the decision-making process. MCA is based upon obtaining input from both experts and stakeholders. These inputs are solicited and synthesized to arrive at a collective decision, or choice, regarding the selection and use of a weighted set of criteria based upon known objectives and indicators. During this step both transportation and development scenarios identified in Steps 5 and 6 were iteratively refined to increase benefits and decrease negative impacts. This step focused on whether or not to implement projects. It worked very closely with the following Step 8.

Step 8: Identify methods to Minimize and Mitigate Unavoidable Impacts

PPACG transportation planning Principle 9 states that the transportation solutions that are selected should be sensitive to the natural and human contexts. SAFETEA-LU requires a transportation plan to discuss mitigation measures that protect, enhance, and restore social, economic, and ecological functions that are the unavoidable result of transportation projects. The desired outcome of this step was to identify and avoid, minimize, mitigate, or remediate negative impacts. This analysis focused on changes within projects that could increase benefit or decrease negative impacts of individual projects. This information was then used to further refine scenarios identified in Steps 5, 6, and 7. Overall policies for different impact categories were also identified.

Step 9: On-going Monitoring / Adaptive Planning

A Continuing, Cooperative and Comprehensive (3-C) planning process requires that policies, programs, plans, and projects integrate and adapt to changes in design, management, and monitoring techniques in order to systematically assess and improve the effectiveness of the planning process and technical analysis. Appraisal techniques themselves must be evaluated and their effectiveness in predicting the outcomes of particular decisions put to the test. Monitoring plays an essential role in providing information on whether a strategy or plan is delivering its desired outcomes. It also assists in the early identification of unintended environmental impacts and provides information to update and fill gaps in baseline data necessary to inform future strategy development.

Integrated Analysis / New Tools and Techniques

Two evaluation tools not previously a part of PPACG transportation planning were used during Steps 2, 3, 4, 5, 7, and 8: Natureserve's *Vista* and Placeways' *CommunityViz*.

Overview of NatureServe Vista

NatureServe *Vista* is a relatively new decision-support tool for land use and conservation evaluation and planning that operates as an extension to the Environmental Systems Research Institute, Inc. (ESRI) software ArcGIS version 9.x. Its primary purposes are to identify high-priority areas for conservation, evaluate competing land-use plans, identify uses that conflict with conservation goals, and compare different stakeholder values and visions in order to highlight areas of agreement or conflict (NatureServe, 2006).

There are two main outputs from NatureServe *Vista*: Conservation Value Summaries and Scenario Evaluations. Conservation Value Summaries (CVS) are straightforward accounts of species richness in a particular area, or they can be used to summarize the overall conservation value of an area by integrating occurrence viability, data confidence, and any number of subjective weights and filters based on special considerations or objectives. For this project, two weighted CVS's, one based on legal protection and management of target species, the other based on CNHP conservation priorities, were run to identify the relative conservation value (low to high) of different areas in the region. Scenario Evaluations indicate areas with compatible land use and adequate protection policies to meet target conservation goals (NatureServe, 2006).

Overview of CommunityViz

CommunityViz is designed to help stakeholders, government agencies, and community members develop, analyze, visualize, and communicate the outcomes of a proposed project or future growth and development. *CommunityViz* produces both dynamic custom outcome analyses and a visual representation of each future scenario to facilitate comparison between scenarios. *CommunityViz* is an extension of ESRI's software ArcGIS version 9.x (Placeways, 2007).

As with all computer modeling and analysis tools, the outputs generated by these tools are only as good as the input data. Ecological and human systems are complex, and comprehensive data is sorely lacking. *CommunityViz* and *Vista* are only support tools. They cannot and should not make decisions for the users; their use should be limited to highlighting areas of perceived importance for further consideration and research. Additionally, *Vista* does not take into account seasonality, either in regard to a species' use of an area or to fluctuating recreational or traffic volumes.

Initial Issue

For analysis purposes it was important to develop a common land-use classification system for the study area. The Colorado Natural Heritage Program (CNHP) worked with PPPCG and Placeways to produce a single land-use classification scheme that would meet analysis needs for multiple tools. The system categorized each zoning code into a major and a minor category. For Vista, additional information on protected public and private lands was added from the Colorado Ownership Management and Protection (COMaP) layer (CNHP, 2008).

Vista Set-up

Biological Conservation Target Selection

A total of 59 conservation targets were chosen for the project: 23 plants, 2 amphibians, 3 reptiles, 12 mammals, 9 birds, 3 fish, 5 insects, and 1 mollusk, plus CNHP-designated Potential Conservation Areas (PCAs). Most targets were chosen based on their previous use in one or more other conservation planning efforts, such as The Nature Conservancy's ecoregional plans or the Colorado Department of Transportation's Shortgrass Prairie Initiative. Several targets, such as the six big-game species, were included at the request of stakeholders. The PCAs were used in lieu of good data on quality wetlands. A PCA is defined by CNHP to be the best estimate of the area necessary to support long-term (100+ years) survival of populations of target species or natural communities. A PCA may require management or restoration to ensure their long-term persistence and functionality, but they do not necessarily preclude other human activities within the area (CNHP, 2007a).

Major Category	Minor Category
Government	Large Military Installations
	Other Government
General Urbanization	Commercial
	Industrial
	Mixed Use
	Office
	Community/ Public Buildings
	Infrastructure/General Urbanization
Residential	High-Density Urban
	Medium-Density Urban
	Low-Density Urban
	Suburban to Exurban
	Exurban to Rural
	Residential Mixed Use
	Undeveloped Private
Parks, Recreation, Greenbelt	Park/Greenbelt
	Protected Open Space
Agriculture*	
Unknown or Road	

Figure 1. Land-use classification scheme.
***Due to limitations of the source data, "Agriculture" is assumed to include both cultivated land and open rangeland.**

Most of the data used to represent target occurrences and viability were derived from CNHP's Biodiversity Tracking and Conservation System (BIOTICS) Element Occurrence, Observation, and Potential Conservation Area datasets (CNHP, 2007b). Big-game data and some supplemental raptor data came from the Colorado Division of Wildlife's Wildlife Resource Information System (WRIS) (CDOW, 2006). Additional fish locations were provided from the Fountain Creek

Watershed Study (URS, 2006). Data that were considered historic or of poor precision were not used. Precise location polygons were used when available. When only point data were available, the points were buffered by 1/10 mile (160 m) in accordance with standard CNHP natural heritage methodology. CNHP data are precise locations, whereas WRIS data for the most part represent broader seasonal distributions of species. WRIS distributions that blanketed the entire study area were not included, because they did not contribute information as to the critical areas to conserve within the two counties. The remaining distributions were combined in an additive manner, resulting in a single layer with ranked areas of importance to each big game species.

Target Integrity and Data Confidence Scores

In addition to species distribution, NatureServe *Vista* also accommodates information on the quality of location and confidence in data used. These scores are ranked from 0 to 1 and are incorporated in *Vista's* Conservation Value Summaries. Each target polygon was ranked as to its quality and level of data confidence. Observation data quality was ranked according to Use Class, big-game data were ranked based on the number of overlapping WRIS distributions and PCAs were ranked based on their Biodiversity Ranking. The fish locations from the Fountain Creek Watershed study were given a single, medium rank of quality due to lack of information. Data confidence ranks were based on mapping precision of Element Occurrence (EO) and Observations, mapping status for PCAs, and single values for WRIS and Fountain Creek Watershed Study data as general indicators of perceived data accuracy.

Land Use Compatibility Designations

Literature review and expert opinion were used to create the compatibility matrix that describes the compatibility of each conservation target with different land uses. NatureServe *Vista* analyzes land use as either compatible or incompatible with each species, existence. The dichotomy of having to designate all land uses as either compatible or incompatible to the persistence of a species or landscape is extremely limiting, especially because not all relevant land uses could be reliably mapped over the project area. A primary example of this is the difference between rangeland and agriculture. Many species are compatible with open rangeland, and very few are compatible with active cultivation of cropland. However, these two land uses could not be reliably distinguished with the available data and so were lumped into one "Agriculture" category.

Conservation Goals and Risk

Conservation goals were based on the Natural Heritage Network Ranking System, taking into account both Global (G-rank) and Subnational (S-Rank) ranks, and using three levels of risk for effectively conserving target species (NatureServe 2002). The low-risk goal set provides the best chance of conserving the species, the high-risk the worst. In evaluating the various scenarios, NatureServe found a clear tipping point between high- and moderate-risk goal sets, but no real difference in evaluation results between moderate- and low-risk goal sets. Because of this finding and the project's time constraints, NatureServe concentrated on evaluating just the Moderate risk goal set against the three scenarios. However, all three goal sets are included in the electronic deliverable for future use. It is important to note that these are broadly applied goals based on a simplified ranking system. Effective conservation of any specific population in a specific area cannot be guaranteed through the use of these goal sets. On-the-ground inventory and monitoring is the only way to assure the effectiveness of conservation efforts for any particular species (CNHP, 2008).

For the legal concern and management summary, each target was ranked based on its level of legal protection, if any, or other level of government-mandated management concern. The U.S. Endangered Species Act takes precedence, followed by the Colorado Endangered Species List, then the Migratory Bird Treaty Act, then USFS & BLM Sensitive Species Lists, and finally management of game species. These ranks are not cumulative. If a species is protected under more than one mandate, then it was assigned the highest weight it could receive. Because PCAs do not receive any legal protection, they were given a weight of zero, which effectively removes them from the summary evaluation. All insects, the one mollusk species, and about half of the plant species on the target list also have no protection and so did not contribute to this summary (CNHP, 2008).

For the CNHP conservation priority summary, each target was ranked by its assigned S-Rank, except for PCAs, which do not have an S-Rank. These areas are already identified as important to conservation of rare and imperiled species and natural communities and were therefore given the highest weight possible. NatureServe *Vista* analysis is based on values ranging from 0 to 1; the highest possible rank is a 1.0. This information was given to Placeways, who utilized in the CommunityViz growth models (CNHP, 2008).

The output of a Conservation Value Summary in Vista is a floating-point grid that ranges in value from zero (0) to a

maximum that depends on the number of overlapping targets, each multiplied by their weights, viability scores, and data confidence scores (if used). The results are difficult to interpret, so the raw output of each CVS was reviewed and refined by CNHP ecologists in order to create discrete polygons representing ecologically relevant areas of conservation importance. Each raw CVS grid was classified into discrete levels of conservation importance (Figure 2). Figure 2 shows that the two analysis summaries, "CNHP High Value" and "Legal Concern," are two different ways of viewing the same data. The value thresholds for these categories were based on relating each combination of target weight and viability score back to CNHP's own ranking methodologies (CNHP, 2008).

Polygons were then manually drawn around all areas of extreme importance while trying to include as many areas of "regular" importance as possible. These delineated polygons may be larger or smaller than the actual "hotspot" areas shown by the CVS grid. All of the areas represented in these two datasets are considered important to conserving either rare and imperiled species (CNHP High Value) or legally protected species (Legal Concern). However, as shown in Figure 3, the polygons have been further subdivided into "tiers." Tier 1 polygons are those of critical importance; Tier 2 polygons are not critical, but are nevertheless important and should not be disregarded. Zonal statistics were run on the final polygons using the original CVS grid as the value layer. The results were appended to the attribute table of the polygon layers. Those polygons that fell within the top 20% of the Zonal Sum value were attributed as Tier 1 polygons with the remainder assigned to Tier 2 (CNHP, 2008).

Reasonable effort was made to represent areas that are both ecologically meaningful and practical for conservation planning, but no guarantee is made that these areas fully meet either condition. Element occurrence and observation data (on which the CVS grid is largely based) are precise locations and do not necessarily reflect the full area required for a population or dependent community to persist. These areas are based on best professional judgment given the time and information available, but are not guaranteed to represent either necessary or sufficient habitat for functioning populations of the target species.

Legal Category	Weight		S-Rank	Weight
USESA			S1	1.00
Endangered	1.00		S2	0.95
Threatened	1.00		S3	0.80
Candidate	0.70		S4	0.66
State Listing			S5	0.10
Endangered	1.00		SU	0.50
Threatened	1.00		SNR	0.50
Candidate	0.70		SNA	0
Migratory Birds	0.80		SX	0
Sensitive Species Lists			SH	0
BLM/USFS	0.60		PCAs	1.00
BLM	0.50			
USFS	0.50			
Big Game	0.125			

Figure 2. Priority weights.

CNHP High Value CVS	Legal Concern CVS	Category
0 to <0.6	0 to <0.6	not of immediate conservation importance
0.6 to <1.0	0.6 to <0.8	important for conservation
1.0 and greater	0.8 and greater	extremely important for conservation

Figure 3. Conversion of summarized conservation value into discrete categories.

Conservation Analyses

Existing Conditions

An Existing Conditions Scenario was created to represent current land use. This land-use layer was input into

NatureServe *Vista* using the *Override* functionality. This functionality creates a single raster layer that describes only one land use present in any one cell. In cases where overlapping land uses exist, a system of precedence is used to determine the dominant land use. The data used to develop Vista's initial Baseline Scenario is very important. These data determine the resolution and accuracy of all future Scenario Evaluations. Therefore, it is very important that Baseline Scenario input data are as robust and accurate as possible.

When NatureServe completed the Existing Conditions Scenario comparison against the moderate-risk goal set, only 39 out of 59 (66%) of the conservation targets met the moderate-risk conservation goals. What this means is that a full one-third of identified species have a moderate risk to their continued survival in the Pikes Peak area, including the three federally listed species that occur in the study area. This is only to be expected, because if they were not threatened by human activities they would not be federally listed. This analysis also points out all of the other species whose long-term viability is threatened and are not yet listed. Of particular note are four species that no longer have lands compatible with their long-term viability remaining in the region. These are the Colorado blue butterfly (*Euphilotes rita coloradensis*), the hog-nosed skunk (*Conepatus leuconotus*), the Front Range alum-root (*Heuchera hallii*), and the Pikes Peak spring parsley (*Oreoxis humilis*).

After the Existing Conditions Scenario was generated, this raster layer was then passed to Placeways for use in growth modeling in *CommunityViz*, which was used to generate two Year 2035 growth scenarios: a "Business As Usual" scenario and an "Enhanced Transportation" scenario. Protected lands, steep slopes, and the proposed Fort Carson conservation buffer were considered during this process.

Creation of Development Scenarios

Scenario Development requires three main inputs: a desirability map, land suitable for development, and the projected population increase from 2005 to 2035. First, a desirability map was created to calculate each polygon's attractiveness to growth and development given no natural, zoning, or capacity constraints. This map gives a desirability score to each polygon based on a number of inputs. The inputs are factors that influence growth and can be weighted in relation to one another.

Next, the buildable land was determined by eliminating water, protected lands, military installations, and roads from the area in which populations could be placed. This input acts as a mask, preventing growth from occurring in these areas. The zoned capacity of the remaining land area was then calculated based on the acreage and allowed dwelling units per acre.

The final step was to allocate the expected population increase to the land-use polygons based on the desirability map. The population is allocated so that the most desirable places fill up first and so that population cannot exceed the zoned capacity.

The analysis evaluated three different growth and development models: Business As Usual, Enhanced Transportation, and Conservation. The Business as Usual model is the default or base model, which assumes that the Colorado Springs region continues to develop in the same pattern, density, and speed that it currently demonstrates. The Enhanced Transportation and Conservation models were created by making alterations to this base model. For the Enhanced Transportation model, bus rapid transit and commuter rail routes and stations were added to the analysis. The zoned density around these areas was increased to allow for more population to be placed near public transportation. For the Conservation model, the land determined by CNHP to be areas of high conservation value were rezoned to "Conservation," thus preventing development in these areas during the allocation process.

After the initial growth models were set up, it was important to collect local knowledge that might not be reflected in other input data. Placeways met with local agency staff to discuss and gather relevant knowledge that could be utilized to further refine the analyses. Local knowledge included natural, social, and political determinants of development, mixed use zoning densities, enhanced transit routes and station locations, and overall development potential. The information was applied to each relevant growth model. Three scenarios were developed and evaluated: Business as Usual, Enhanced Transportation, and Conservation of Critical Lands.

Business As Usual Scenario

The Business As Usual model, adopted by the PPACG Board of Directors as the official forecast for air quality conformity purposes, continues policies that have produced the current regional growth pattern. This forecast was originally conducted using TELUM in order to begin to incorporate travel conditions into location of growth forecasts. The results

were then paralleled in *Communityviz* by changing attraction and repulsion levels until the two results mirrored each other. The resulting scenario predicts that development will continue to grow outward from the core of Colorado Springs. When NatureServe evaluated the Business as Usual land development scenarios less than half (29 out of 59 or 49%) of the conservation targets met the moderate-risk conservation goals and six additional (a total of 10) species did not have any occurrences of compatible lands remaining. Those newly identified species are the roadside skipper (*Amblyscirtes simius*), Gunnison's prairie dog (*Cynomys gunnisoni*), Townsend's big-eared bat (*Plecotus townsendii pallescens*), Front Range milkvetch (*Astragalus sparsiflorus*), Front Range alum-root (*Heuchera hallii*), and Porter feathergrass (*Ptilagrostis porteri*). Figure 4 shows the location of growth in the Business as Usual scenario.

Enhanced Transportation Scenario

This scenario utilized existing zoning policies, applied in ways that differ slightly from current implementation. Specifically, this scenario included the installation of a bus rapid-transportation system in Colorado Springs as well as a commuter rail line along the Front Range. These new transit facilities served to focus regional growth using existing mixed-use zoning policies within ¼ mile of the transit facilities. The corridors for Colorado Springs' four bus rapid-transit lines were obtained from the Colorado Springs Rapid Transit Feasibility Study and System Master Plan and were enhanced with input from the local staff. The station stops for the commuter rail route were located along the Burlington Northern Santa Fe based on current intersections of transportation networks, downtowns, and population centers. Figure 5 shows the location of growth in the Enhanced Transportation Scenario. The size of the Transportation Analysis Zones masks much of the detail associated with the implementation of transit corridors.

The Enhanced Transportation Model demonstrated a growth pattern that was more compact with mixed uses compared to Business As Usual. Densification appears most notably around the nodes and corridors of the bus rapid-transit systems. When NatureServe evaluated the Enhanced Transportation Scenario, 28 out of 59 (47%) of the conservation targets met the moderate-risk conservation goals (Table 11). Differences between this scenario and the Business As Usual scenario are the greatly increased densities along the transit corridors, which creates more incompatibilities in these areas. The one additional target that did not meet goals in this scenario compared to Business as Usual is the Ferruginous Hawk (*Buteo regalis*), which went from 4 occurrences (121% of goal) on compatible land uses to 3 (91%).

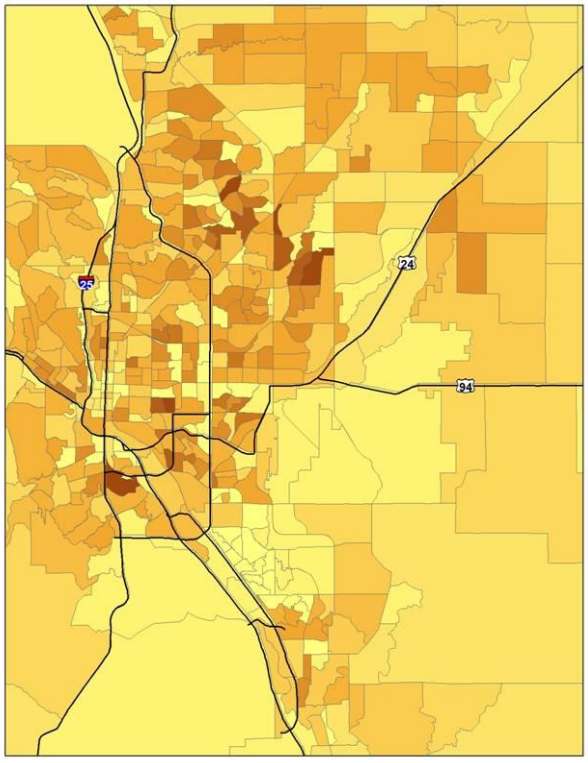

Figure 4. Location of regional growth under Business As Usual. Darker indicates more growth.

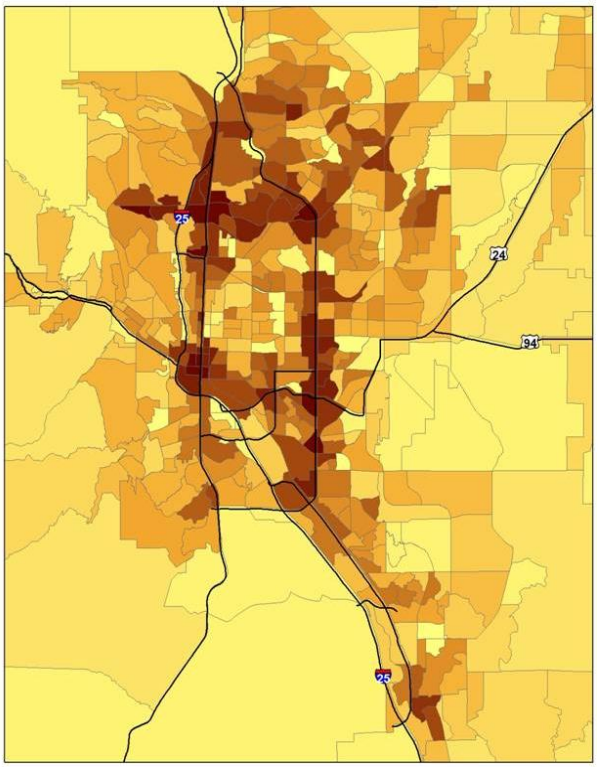

Figure 5. Location of regional growth under Enhanced Transportation. Darker indicates more growth.

Conservation of Critical Lands

Vista's Site Explorer tool is an interactive conservation planning tool that allows users to point-and-click on land-use parcels within the project area and view the presence and condition of conservation targets within the parcel(s). Parcel units are determined by designating the spatial layer to use on the Scenario Evaluation form. After identifying the properties of conservation targets within the parcels, users can develop mitigations by changing the land use in a parcel to a use that supports the health and persistence of that target (i.e., a land use that has been designated as "compatible"). These land-use changes, or mitigations, can be exported as shapefiles and incorporated into Communityviz scenarios.

This exercise created an example Conservation of Critical Lands Scenario and evaluated it against the other scenarios. NatureServe staff selected parcels with high concentrations of conservation targets and changed them to various compatible land uses. When this example scenario was evaluated using the Business As Usual growth model, the number of conservation targets that met the conservation goals increased from 29 to 30. The Conservation model produced a scenario similar to the Business As Usual model, with the growth pattern appearing like an extension to the current growth pattern. What changed most dramatically was that the location of development occurred further from the urban core, creating a "leap-frog" effect.

Summary

Areas of greatest conservation value and regulatory concern were initially identified in *Vista*, refined by ecologists and then entered into *CommunityViz* growth models as areas where new or continued growth is undesirable. The growth models produced future development scenarios, which were then passed back into *Vista* for evaluation against conservation goals. These growth scenarios were iteratively input into the travel demand model to evaluate traffic conditions.

The *Vista* analyses highlight species that are threatened, either by existing or potentially planned development, including those that are not yet federally listed under the Endangered Species Act. This information can help planners be proactive in their development plans and reassure regulatory entities that conservation values are being taken seriously and incorporated early in the process. Both the Business As Usual and Enhanced Transportation scenarios created undesirable impacts on conservation targets, and further study showed that there are some species that cannot successfully be protected within the Pikes Peak region given forecast levels of growth.

The analyses in *CommunityViz* showed two key factors in the growth and development pattern of the study area. First, it showed that a bus rapid-transit system does have the potential to concentrate growth around city centers. It also showed that a conservation plan, applied in conjunction with a transportation plan, is more effective than either done separately. In the Conservation scenario, development was shown to leap-frog land that was removed from development for conservation purposes, thus producing little change from the Business As Usual scenario. A combined transportation and conservation plan has the potential to focus development around city centers while relieving development pressure on land that can help to meet conservation goals.

The authors of this report would like to emphasize that all results given here and in the accompanying electronic data are preliminary and based entirely on available spatial data, which may not accurately reflect conditions on the ground. Consultation with appropriate state and federal regulatory agencies is always necessary, and planners are urged to conduct on-the-ground biological and reconnaissance surveys, and to solicit public comment before finalizing any plans. More detailed or up-to-date data may significantly change the results of these initial growth models and scenario evaluations.

This project's greatest value can only be realized by using the databases, methods, and expert knowledge hand-in-hand. The general trends identified in this project are predictable: a loss of conservation targets due to increased growth. However, the spatial analyses in this project provide probable causes and locations for the loss of specific target species. With this precious information planners can identify problem spots and focus attention on those areas containing the species of greatest concern. As land-use changes are made, planners can then reevaluate the status of conservation targets, getting quantitative feedback about the impact of their decisions. The first and most productive initial step may be simply to identify those locations where species are incompatible with the land use, and local knowledge suggests that there is an opportunity to modify that land use.

Mitigation

An important point to note is that conservation goals were not met for a full third of the targets in the Existing Conditions scenario. This indicates that planners should already be concerned about the long-term viability of a number of rare and imperiled species in El Paso County, and that continued urban development will worsen the situation, even with proactive action. These analyses and discussions with resource agencies have led to PPACG considering using off-site and out-of-kind compensatory mitigation to proactively protect key species in the Pikes Peak region.

Off-site out-of-kind mitigation could increase conservation benefits by proactively protecting a large resource or a complex of habitats that would accomplish other goals and avoid discontinuous mitigation sites that are surrounded by urban features that will suffer increasing pressures. By focusing on species most heavily impacted by the growth projections that can be protected in the region, and using conservation principles for those species out-of-kind out-of-region, efficient and cost-effective gains can be made for conservation targets.

Two specific species that could benefit from this approach are the Townsend's big-eared bat, which is a candidate species for state listing and is considered imperiled in the state of Colorado (S2), and the Porter feathergrass, which occurs only in Colorado and is also considered imperiled. Neither of these species is currently threatened within El Paso County (as modeled by the Baseline scenario), but both become highly threatened in all of the future scenarios considered. Several other species and the Potential Conservation Areas follow this same pattern, which is also a concern, but the Townsend's big-eared bat and Porter feathergrass are the most vulnerable of these targets in the state.

While the Mitigation scenario produced during the study is only one example, it demonstrates how *Vista* can take scenarios generated by *CommunityViz* growth models and manually protect some individual parcels to refine planning objectives to best meet conservation goals. Combining local knowledge with the predictions of goal achievement for target species can yield results that are informed by ecologic and economic models, as well as an *in situ* understanding of realistic pressures and opportunities across the project area.

Conclusions and Recommendations

The primary outcomes of the PPACG process are better informed citizens, while decision-makers have more understanding of the relative priorities of citizens and impact tradeoffs between transportation investment decisions and other planning and development decisions. This planning framework depicts the decision-making process in a way that makes it ideally suited to communicate the basis of each decision. This communication is rigorous enough that it is likely to produce documentation and analysis that can be carried into the NEPA project development process. Another discovery by the study team is that a technical process that produces results that are expected/desired by elected leaders is considered much more accurate than one that produces something unexpected. Further refinement of the process and tools to generate a more complete accounting of the direct, indirect, and cumulative impacts of policies and investments is warranted.

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