APPLYING
CONSERVATION PLANNING TOOLS

CASE STUDY:
PIKES PEAK REGIONAL TRANSPORTATION PLAN

Funded by the U.S. Department of Agriculture, Forest Service

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Formed in 1967 under Colorado law, the Pikes Peak Area Council of Governments (PPACG) is a voluntary organization of municipal and county governments serving a regional community. For 45 years, PPACG has worked to ensure that all communities—big and small—have a forum to discuss issues that cross their political boundaries, identify shared opportunities and challenges, and develop collaborative strategies for action. These intercommunity relationships underpin the concept of regionalism and the mission of PPACG.

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INTRODUCTION

The following case study is the result of a partnership between the American Planning Association (APA), NatureServe, Placeways, the Colorado Natural Heritage Program and the Pikes Peak Area Council of Governments (PPACG). The case study represents a follow-up study to a 2011 assessment of planners’ use of GIS-based software capable of supporting conservation planning efforts, the results of which are located on the APA website (see references and resources on page 23). APA worked with conservation biologists and GIS specialists in the development and analysis of the assessment. Both the 2011 assessment and the following case study were made possible through funding and staff assistance from the United States Department of Agriculture, Forest Service.

Based in biological science, “conservation planning” is a growing field that works to identify those areas of land and water that hold the greatest promise for long-term biodiversity protection. Many new advanced tools in conservation planning are offering new insights and modes of inquiry, particularly those that utilize Geographic Information Systems (GIS) to visualize, question, and interpret data. The 2011 Conservation Planning Tools Assessment was created to assess and better understand planners’ use of and needs for conservation planning tools, particularly GIS-based applications.

A number of revealing findings surfaced in the 2011 assessment that surveyed 1,872 planners who work in the conservation field. Planners reported frequent use of GIS in their work, but in a fairly limited capacity as it relates to conservation when considering the rapidly evolving realm of conservation-related tools now available. With the variety of work planners almost invariably undertake for any planning process, it’s probably unreasonable to expect any significant portion of them to become advanced users of most these tools. Planners were much more familiar with a couple of particular planning support systems, UrbanSim and Community VIZ, versus others mentioned in the survey. This was unsurprising because those tools were actually designed for planners. The other tools listed in the survey, however, were not specifically designed with planners in mind. In general, most of the others (e.g., Corridor Designer, Climate Wizard, and Circuitscape) were designed to aid the fields of spatial ecology and conservation biology. With the proliferation of tools designed to further conservation, planners are now, theoretically, in a better position to integrate conservation into their plans. However, increased collaboration among planners and conservation experts such as ecologists and biologists, many of whom have expertise with these tools, is needed.

It is unlikely, and unnecessary, for that matter, for planners to become experts in the expanding range of GIS-based conservation planning tools. But it is important that planners, as generalists, become and stay aware of the spectrum of possibilities within their work. The results from the 2011 assessment, in fact, show a considerably low awareness rate among planners for most of the conservation planning tools listed. This case study demonstrates some of the current capabilities and how they can aid the planning process.

Communities frequently need a variety of implementation tools to reach their preservation goals. Urban growth boundaries, transfer of development rights (TDR), purchase of development rights (PDR), rural land stewardship, land and easement acquisitions, zoning, and a wide variety of funding mechanisms all contribute to different communities’ success. Myriad types of partnerships with universities, land trusts, private environmental organizations, and agencies from local, regional, state and federal governments are also critically important pieces to the complex nature of motivating, strategizing, and implementing effective preservation programs. In the same way, the following case study uses not just one, but rather a collection of software tools to support a complex regional planning effort in the Pikes Peak region - a process that will continue to require the skills and expertise of many groups and individuals.
PROJECT OVERVIEW

The Pikes Peak Area Council of Governments (PPACG) is the designated Metropolitan Planning Organization (MPO) for the Colorado Springs Urbanized Area. 16 member organizations belong to PPACG, a group of 16 municipalities across three counties. PPACG assists the member local governments in coordinating decisions that affect the Pikes Peak region. The City of Colorado Springs is the largest municipality in the area with a population of 416,427 (according to 2010 Census data). In 2004, the city of Colorado Springs was noted by the Texas Transportation Institute as the most congested city under 500,000 in the nation. In response to this, the region approved a one cent sales tax (approximately $65 million per year) dedicated to transportation improvements that is administered by PPACG.

Figure 1: The designated Metropolitan area, shown above, includes the Colorado Springs Urban Area, the Woodland Park Urban Cluster, and the Air Force Academy Urban Cluster as well as the areas that are forecast to have noticeable development within the next 25 years.
In order to better account for the needs and desires of agencies that impact, or are impacted by, transportation investments, PPACG requested and received participation in the process by agencies that have not traditionally participated. This group was called the Extended Transportation Advisory Committee (ETAC) and included participation from the Colorado Division of Wildlife, Colorado Department of Public Health and Environment, Colorado Department of Transportation, U.S. Fish and Wildlife Service, Environmental Protection Agency, Colorado Springs Housing Authority, El Paso County Departments of Economic Development and Community Services, the El Paso County Department of Health, and other local or neighborhood organizations. The ETAC also included representation from PPACG’s transportation advisory committee, which is made up of the transportation staff at the local governments.

PPACG is widely recognized as a center of innovation for transportation and integrated land use planning. The COG has been the subject of multiple pilot projects for new transportation research, guidance, and planning approaches to enhance the “Regional Modelling System” tools and processes used to develop long range plans and short range investment programs. That said, PPACG’s capabilities in the area of conservation planning are probably typical of other COGs and MPOs or other local land use planning offices, meaning that this is a new area for them and they lack expertise in conservation planning and have experienced declining staffing due to budget cuts. A key consideration then is how to work with other organizations with such expertise to apply advanced approaches and tools to land use and conservation planning. This case study describes the recent and current projects in PPACG to first apply a decision support toolkit to develop its 2035 long range transportation planning effort called the 2035 Moving Forward Update (and appropriate land use pattern); and second, to develop an advance mitigation plan to aid implementation of the 2035 plan. The advance mitigation plan identifies locations that can provide offsite mitigation to impacts that could not be avoided in the 25-year plan. This work was stimulated and largely funded through research and innovation grants originating with transportation agencies (Federal Highways Administration—FHWA, and the Transportation Research Board of the National Academies of Science--TRB). Projects were designed to test, demonstrate, and/or implement new innovations in transportation planning such as FHWA’s Planning and Environment Linkages (PEL) initiative, the Transportation for Communities—Advancing Projects through Partnerships (TCAPP), and the Integrated Ecological Framework (IEF). Although these initiatives are strongly oriented to transportation planning, they incorporate land use as a key driver of transportation needs and cumulative impacts on the environment.

DECISION SUPPORT TOOLKIT

While this case study is about the use of software tools to aid conservation planning, the use of tools does not inherently solve human dimension issues of inadequate funding and staff capacity, stove-piped organizations and process, and lack of collaboration and political will. Rather the tools are meant to facilitate better and more efficient planning and collaboration when there is the will and support for these important planning facets.

WHAT IS A TOOLKIT?

We define a tool in this case study as a software product meant to support planning or a specific planning component. A toolkit then, is a collection of software tools working together (interoperating) to support a particular workflow that moves from raw inputs, through analyses, to decision support products (maps, reports, etc.). Toolkits are needed for complex cross-sector planning such as the integration of biodiversity conservation with land use and transportation planning. While the application of the toolkit is an important part of the process, a single user or even organization need not develop the expertise to operate all parts of the toolkit. Rather, a collaborative planning process with the organizations that can provide specific skills and expertise is needed.
TOOLKIT FUNCTIONS

For the PPACG projects, a multiple tool toolkit was selected that could address the needed workflow. Key functional needs for the toolkit included the following (specific tools are listed for each function so they can be cross-referenced to the tool descriptions that follow):

• Generating urban growth scenarios and socioeconomic indicators based on different transportation and land use pattern concepts (CommunityViz).

• Integrating urban growth model outputs with other stressors, conservation areas and practices to form complete cumulative effects scenarios (NatureServe Vista, N-SPECT).

• Integrating information on biodiversity (ecosystems, habitats, species, and existing conservation priority areas) and expert knowledge on the conservation requirements and sensitivities of these “conservation elements” (NatureServe Vista).

• Visualizing patterns in conservation value and priority across the planning region (NatureServe Vista).

• Conducting cumulative effects assessment of how and where the land use and transportation scenarios would impact the conservation elements (NatureServe Vista, N-SPECT).

• Generating alternatives that reduce conflict between conservation and development objectives and locations (iteration among NatureServe Vista, N-SPECT, Marxan, and CommunityViz).

The above functions fulfilled the needs for the initial project to develop an acceptable Long Range Transportation Plan. The following functions support development and implementation of the advance mitigation plan:

• Providing results of the assessment of impacts that could not be avoided online for partner “truthing” and commenting (NatureServe Vista with Google Earth).

• Generating optimal selection of sites to provide offsite mitigation (Marxan).

• Evaluating the site selection and refining it into an advance mitigation plan (NatureServe Vista).

• Providing the mitigation plan online and facilitating identification of interest and capacity for implementing mitigation for sites (Google Earth).

THE TOOLS

NatureServe Vista™

Vista is a free extension to Esri’s ArcGIS desktop platform. Vista covers a broad range of assessment and planning functions from integrating source spatial data and expert knowledge, characterizing spatial scenarios and conducting cumulative effects assessment, to developing site mitigations or entire new alternatives. It is focused on integration conservation with other development activities. Vista is intended for use by planners and managers but requires initial set up by mid-range GIS analysts and appropriate subject matter experts. It also has a wizard to work directly with Marxan (see below).

CommunityViz®

CommunityViz planning software is an extension for ArcGIS Desktop, available for a modest license fee. It assists planners with decisions about development, land use, transportation, conservation and more. CommunityViz “shows” you the implications of different plans and choices. Both flexible and robust, it supports scenario planning, sketch planning, 3-D visualization, suitability analysis, impact assessment, growth modeling and other popular techniques. Its many layers of functionality make it useful for a wide range of skill levels and applications.
Marxan
Marxan is a free but highly specialized tool used to develop efficient networks for conservation. It incorporates information about the locations of conservation targets (e.g., habitats), the quantity of the target to be retained, and a layer representing the cost of achieving conservation in any location (usually represented by a map of the current condition/threats to conservation but can be actual economic cost). Marxan is a free-standing tool but the developer does provide a free open-source GIS (Zonae Cognito) that can be used with it. Marxan is an expert tool but its use is eased through Vista’s Marxan wizard that prepares inputs to Marxan and then imports the results back to Vista.

N-SPECT
The Non-point Source Erosion and Comparison Tool (N-SPECT) is a free plugin to the free MapWindow GIS open-source platform tool. N-SPECT operates on scenarios of land use/land cover (as generated through CommunityViz and Vista in this project) to forecast water runoff volume and amounts of pollutants (sediment, nutrients, and certain toxins). It depicts both where the pollutants are originating and in what volumes and where they end up (note it does not model more complex hydrologic processes such as re-suspension of pollutants). N-SPECT has similar operation requirements as Vista—planners and managers can run it after initial population of the model by experts.

Google Earth
Google Earth is a free online tool that allows the incorporation of maps, photos, and text to support mapping and visualization (including 3-D) to explore locations. In this project, a secure Google Earth project is planned that will incorporate the adopted plan, the Vista evaluation of remaining conflicts, an advanced mitigation plan developed through Vista and supporting information. The intent is to give collaborating agencies and stakeholders access to the site to explore and understand the plans and evaluations and to be able to place geographic notes to comment on locations to aid refinement as well as indicate interest in helping implement mitigations.
THE TOOLKIT WORKFLOW

A workflow visually communicates the processes that the toolkit is to support and the interactions among the tools such as importing the outputs from one tool into another tool for analysis (see Crist et al. 2013 for more information about workflows and toolkits - full reference on page 23). This high level workflow shows the basic roles and interactions of the tools. More complex diagrams were developed that illustrate specific function to function interactions among the tools to guide technical users. Key functions are further described and illustrated below.

Figure 2: The toolkit workflow illustrates the scenario basis for the planning process which is supported by all of the tools. The Baseline Scenario evaluates the current actual land use and infrastructure (and other ecological stressors and conservation uses). The Trend Scenario uses the Baseline Scenario and current plans to model and evaluate the likely future landscape. Stakeholder engagement (occurring throughout the process) uses evaluation results to identify the needs for change, strategies for change, and revised objectives if needed. The Preferred Scenario acts on these recommendations through multiple iterations to create an acceptable alternative that meets the objectives. Plan implementation is facilitated through a Google Earth interface to the information that supports stakeholder identification of their implementation interests. Cviz=CommunityViz; Vista=NatureServe Vista; N-SPECT=Nonpoint Source Pollution and Erosion Comparison Tool; Marxan is a conservation solution optimization tool; and Google Earth is an online map interface.
CHARACTERIZING SCENARIOS

We use the term “scenarios” here to describe a mapped depiction of the myriad land uses, infrastructure, conservation areas, and stressors at any point in time, or alternatives for the same point in time. Scenarios are, ideally, “wall-to-wall,” meaning they provide the above information for all areas of the planning region rather than just for specific planning jurisdictions. This is important to provide spatial context to planning decisions and incorporate stressor effects and ecosystem processes transcending jurisdictional boundaries. In the case of PPACG, there are large federal land areas in PPACG’s region that contain habitats and species that span private and public lands. Inclusion of all areas in the scenarios allows for an accurate assessment of how these conservation elements fare throughout the region and can support a shared understanding among collaborating agencies and jurisdictions such as in a Council of Governments.

THE BASELINE SCENARIO

Our scenarios begin with what we term the “baseline,” or current conditions scenario. Often, planning starts with the current plan to understand where and how changes should be made for a plan update. However, it is highly useful to begin with an assessment of the current actual land use and other stressors to understand if, where, and why the current situation is not supporting conservation and development objectives. To create this scenario, data on current land use, infrastructure, and conservation areas (representing conservation land use) were brought into CommunityViz to support growth modeling for the future. The current data was then imported to Vista where additional data could be added such as locations of invasive species that can contribute to impacts on conservation elements.

ALTERNATIVE FUTURE SCENARIOS

After the baseline scenario was created, it was used to help generate and explore multiple alternative futures. The first future explored is what we termed the “current growth trend scenario” (utilizing past patterns and the existing “small area forecast” - a growth allocation process PPACG conducts every four years). From there, other alternatives could be explored such as an infill/cluster scenario that added density to downtown corridors and changed low-density subdivisions into clusters with higher density and mixed use. The last scenario was the conservation scenario that avoided development in areas of high conservation value based on analyses described above. See Figure 3 below for a side-by-side comparison of the baseline scenario with the projected build-out scenario.
Figure 3: Comparison of the current condition or baseline scenario (left) and build-out scenario (right) generated through CommunityViz and then imported into Vista and aug-mented with other data. The build-out indicates significant new growth to the east of the Colorado Springs metro region.
ASSESSING CUMULATIVE SCENARIO EFFECTS

Once scenarios are generated, they can then be assessed against goals or indicators established to inform generally whether an alternative supports goals or does not. More specifically, the evaluation can identify what goals are not being supported, where, and why; and this information can then be used to generate better alternatives. Multiple tools from the toolkit were involved in the assessment: CommunityViz incorporates many socioeconomic indicators that reflect important attributes of each scenario and these can be compared to desired objectives or thresholds for development; Vista assesses how the scenarios support or impact the conservation elements which are assigned quantitative retention goals (e.g., what percent of current element distributions should be retained in a viable state); N-SPECT was used to evaluate changes in sedimentation and nutrient inputs to streams based on land cover (and then those results imported into Vista to assess impacts on aquatic habitats and species). Each of the tools provides maps that identify what features are being affected and where, along with tabular results quantifying the impacts. See Figures 4 and 5 below for examples of the generated results.
Applying Conservation Planning Tools

Figure 4: Comparison of scenario evaluations in Vista. Left is the Current or Baseline Scenario of actual land use and infrastructure. Right is the Build out Scenario based on current plans. Tan areas have conservation elements (e.g., habitats) that have met their retention goals under the scenario and/or no conflict in those locations. Pink to red areas are where conservation elements occur that have not met their goals and are in conflict with features in the scenario at those locations. The darker the shade of red, the greater the number of elements in conflict.
Figure 5: Example quantitative report from the Vista cumulative effects assessment. For each conservation element, the report provides the current area, the goal, whether the goal was met, the forecast of how much of the goal would remain if the scenario fully played out, and the distribution of potential conservation area. The table shows the data for different elements and systems.
CREATING THE PREFERRED PLAN

Marxan was used to help generate the conservation alternative. The spatial data and objectives for Marxan were generated through the Vista Marxan wizard and then Marxan generated millions of possible solutions along with a “best” solution. From this result, one can identify the “relative irreplaceability” of each site in the planning region based on how often it is selected as part of the conservation solution. The most efficient solution was then imported into Vista and further refined for the conservation alternative. Using the three alternatives as a starting point, a mediated workshop was held at PPACG between representatives of the local municipalities’ technical staff for transportation and development planning. Based on input from the workshop participants, the three scenarios were refined and then combined to create a single “preferred growth” scenario. Despite the extremely collaborative nature of the effort, as is common in such processes, there were aspects of the alternative that were acceptable as well as undesirable for each participant. The combined alternative was then accepted as the 2035 plan. See Figures 6, 7 and 8 below.
Figure 6: Results of Marxan run to identify optimal locations to meet conservation objectives. Vista provides a wizard function to create the inputs to Marxan and then the result can be imported back into Vista for further spatial refinement and specification of desired land uses and implementation mechanisms and policies for each location.
Conservation A (emphasis on conserving rare & imperiled species)

Figure 7: One of the conservation alternatives produced for the project. This one emphasized conservation of rare and imperiled species.
Figure 8: Residential density change 2010-2035 for the preferred scenario.
PLANNING FOR ADVANCE MITIGATION

This activity is underway as of this writing. Recognizing that all plans must compromise competing objectives, there are many remaining conflicts between development and conservation objectives that could not be mitigated through avoidance (separating development from high-value conservation areas). The first step then is to evaluate the preferred/adopted plan for these “residual” impacts and quantify the amount of area (or occurrences) of each conservation element impacted. Next, the toolkit is employed to identify areas not planned for development that could offer offsite mitigation opportunities as the plan is implemented with proposed development projects.

In this activity, Vista will be used to evaluate the preferred plan and calculate the residual impacts relative to conservation goals for the conservation elements. Marxan will likely be used to take those residual impact quantities as goals and seek out a least-cost solution for a network of mitigation areas. “Least cost” in this case could combine avoiding areas highly desired for development and promoting areas with high ecological intactness/condition. The Marxan result would then be refined in Vista to be easier to implement and have a spatial design better able to meet the viability requirements of the conservation elements. Finally, the mitigation plan would be placed on a secure Google Earth site to allow detailed investigation by partners and stakeholder with potential ability to comment on specific locations and indicate their interest in helping implement particular locations.

MAINTAINING THE SYSTEM

Decision support systems can be useful for single applications to large, lengthy, complex projects where they can provide the ability to rapidly conduct many iterations or alternatives and provide better documentation of the process than manual methods. However, the best use for such a system is to support the full project lifecycle from plan development through implementation to later plan updates. Maintaining these systems has the primary benefit of never having the data and system become obsolete (assuming the tools are maintained) and having to start from scratch with every plan update. This approach also maintains a clear connection between plans and implementation actions. Maintenance does have ongoing needs and costs such as:

• Technical integration with organization systems and databases. This can present challenges when there are differences in underlying platforms, data structures, etc. that are in conflict with the tools.
• Training of staff and ongoing technical support from tool providers. These types of agencies are prone to high turnover so it is important to not become reliant on a single staff “expert” in the system.
• Commitment to updating the toolkit database such as entering actual land use changes into the “baseline” scenario along with more routine data improvements such as new land cover maps and periodic review and updating of expert knowledge. Because data gathering remains the largest time investment in any planning process, conducting ongoing incremental data maintenance should significantly reduce the time and cost of future plan updates.
• Periodic reassessment of the current situation, project proposals, and local area plans against the conservation element and development objectives to understand when and where plan changes are needed. This reassessment is obviously dependent on data maintenance and is important to assure that the original plan objectives are being met.

For PPACG, previous projects relied on the tool developers to operate the toolkit; this is common because of the learning curve for adopting tools and fully integrating their use with prior approaches and systems. Now that the initial plan is complete and the advance mitigation plan is underway, PPACG is looking toward the need for ongoing plan implementation and updating and is committed to integrating NatureServe Vista into its operations.
KEY CHALLENGES

Activities as large and complex as long range transportation planning, coupled with land use planning generate several challenges. Key challenges include:

• Maintaining participation from partner/stakeholder agencies and organizations. Many factors affect participation which is key to a collaborative planning process. Changes in staff and partner participants during the duration of the project are a common challenge but are especially problematic when using a collaborative planning process. Ensuring organizational buy-in and commitment rather than just individual commitment is important for mitigating this challenge. Also in this project, the more robust evaluation of impacts from locally-desired transportation projects (environmental and socioeconomic) caused some participants to drop out because they did not want the analyses to affect a-priori support for those projects.

• Related to the above challenge is the necessarily diffuse decision making in collaborative regional planning in general, and specifically for transportation that involves the regional entity (PPACG in this case), its local government members, and the state department of transportation. Each entity has different roles, responsibilities, and values in the outcome and there is no shortcut to working through the collaboration and negotiation processes necessary to reach consensus. The role of the tools is to provide sound, objective results to inform discussions and ease the process of developing and testing alternatives.

• Obtaining and using secure data, such as the rare and imperiled species location data that informed this project, presents challenges in providing detailed results and transparency to participants. In the case of this project, the data owner (Colorado Natural Heritage Program) conducted the assessment work with the finest level secure data and then created more generalized conservation priority areas that could be provided to PPACG staff in their Vista DSS.

• Obtaining the expert knowledge needed to provide parameters to the toolkit such as conservation element requirements and sensitivities and for socioeconomic indicators (Muller et al. 2006, Paulsen et al. 2010). This is a critical challenge and is highly dependent on the disposition of the individuals involved. It is helpful to engage experts that have been involved in planning processes rather than just project level NEPA review who tend to be less willing to provide the more subjective region-wide parameters that are needed. Related to this, PPACG found that their stakeholders had great difficulty creating measureable goals (e.g., for sediment reduction) without good baseline data and also were uncomfortable with reliance on experts to generate parameters based on their opinion versus empirical study (note that experts are equally uncomfortable with this but such studies are rare and these decisions are inherently made whether explicitly or not).

CONCLUSIONS

The use of technical tools in planning has many benefits but is not a panacea for the typical political challenges in developing plans. The change in the PPACG planning process to integrate more non-transportation considerations not only resulted in utilization of more comprehensive data and analyses, but also resulted in consideration of issues that wouldn’t have come out without having partner agency experts participating in the decision-making process. One example of this was consideration of the impact of noise on particular species. In addition, it was commented that participating in the planning process, the natural resource agency staff ended up with a better understanding of the transportation planning process, and saw how their input was influencing the planning outcomes which kept them engaged

Some PPACG staff felt that the increased stakeholder involvement resulted in the most significant improvement to the outcomes of the 2035 planning effort. Stakeholder input was taken and integrated into the planning process at several points, which resulted in the stakeholders being more confident that their input was
being utilized at the regional level and thus they felt more invested in the process. In addition, when the selection of the preferred scenario was completed most stakeholders felt comfortable with the decision, even though there were short comings to the final scenario, because they understood why and how this scenario was selected.

Furthermore, PPACG utilized scenario modeling as recommended under the TCAPP guidance and this supported a clear demonstration of the costs and benefits of each scenario being considered and vastly helped the evaluation and selection of the preferred scenario by stakeholders. Being able to provide stakeholders with an interactive view of scenario models allowed them to make changes/decisions and then ‘test’ the outcomes of various models. This was very supportive to the selection of the preferred scenarios. Overall, scenario planning was the most helpful part of the process in terms of engaging stakeholders and making better informed decisions.

A key outcome of this project was the understanding of how important collaboration is in all planning but specifically when integrating a specialized component like conservation into land use and transportation planning. Collaboration addresses a number of needs such as:

- Political agreement on vision, objectives, and solutions;
- Cross-sector planning process integration; in this case integrating land use, transportation, and conservation into a single planning process;
- Scientific knowledge incorporation from a variety of sources; and
- Data acquisition from a variety of sources that may involve dealing with secure data that cannot be shared and data providers that are invested in how their data are used.

Software tools have a roll in facilitating collaboration. As the tool providers like to say “You can’t just parachute tools into a process and expect good things to happen. The tools should facilitate, not get in the way.” Some specific ways that the tools facilitate collaboration include:

- **Integrating assessment and planning across sectors using a common database.** This is accomplished in this toolkit with the scenario-based approach where land use and conservation scenarios can be shared and evaluated across tools and each tool can be used to propose alternatives or modifications until an acceptable solution is reached.

- **Integrating expert knowledge.** Each of the tools requires they be populated with information from different subject matter experts that can be documented and used to generate analyses.

- **Integrating objectives.** The tools provide the ability to state and set objectives for different indicators or metrics such as retention goals for habitats and amount of housing units of different types. This facilitates evaluation of alternatives against objectives so a project team always knows how each alternative performs against all of the objectives.
LIST OF REFERENCES & RESOURCES

http://www.planning.org/partnerships/forestservice/

Tools Used in Case Study:
NatureServe Vista™  www.natureserve.org/vista
CommunityViz®  http://placeways.com/communityviz/
Marxan  http://www.uq.edu.au/marxan/
N-SPECT  http://nspect.codeplex.com/
Google Earth  http://www.google.com/earth/

PPACG Reports:
2035 Moving Forward Regional Transportation Plan.

Integrated Ecological Framework (IEF):
Institute for Natural Resources. Oregon University and partners. Funded by TRB.
http://oregonstate.edu/inr/ief

Articles:
https://www.google.com/search?q=AREAWIDE+CUMULATIVE+EFFECTS+ANALYSIS+USING+GIS&oq=AREAWIDE+CUMULATIVE+EFFECTS+ANALYSIS+USING+GIS&aqs=chrome..69i57.877j0j7&sourceid=chrome&espv=210&es_sm=93&ie=UTF-8#

Other Related Resources:
Planning and Environment Linkages (PEL):  
http://www.environment.fhwa.dot.gov/integ/

Transportation for Communities - Advancing Projects Through Partnerships (TCAPP):
http://transportationforcommunities.com/