Application of Geospatial Ecological Tools and Data in the Planning and Programming Phases of Delivering New Highway Capacity: Proof of Concept—East-West Gateway Council of Governments

DETAILS

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SHRP 2 Capability Project C40B2

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STRATEGIC HIGHWAY RESEARCH PROGRAM
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Executive Summary

The second Strategic Highway Research Program (SHRP 2) C40B2 Proof of Concept advances the goals of SHRP 2 CO6A and CO6B, and, in particular, shows how application of a geospatial tool can support integrated ecological planning at regional and local levels. This report addresses the work conducted by the East-West Gateway Council of Governments (the Council) and the Missouri Resource Assessment Partnership (MoRAP) as co-principal investigators on the C40B2 Proof of Concept. The Council and MoRAP (C40B2 team) developed an ecological geospatial tool from 2008–2013 as a part of the Council's Ecological Approach to Infrastructure Development Initiative (Ecological Initiative). An ecological geospatial tool (Ecological Initiative tool) was developed to encourage proactive avoidance of ecologically significant natural resource areas in the Saint Louis region and to target mitigation and restoration efforts in locations of the most benefit toward regional conservation goals. The Ecological Initiative tool was applied at the regional level in the Regional Transportation Plan 2040 (RTP 2040), the region's long-range transportation plan. The Ecological Initiative is working to incorporate the tool into the work of regulatory and resource agencies in pre–National Environmental Policy Act (pre-NEPA) planning, natural resource mitigation, and wetland restoration in cases of unavoidable impacts. .

By taking part in the C40B2 project, the C40B2 team was able to explore the regulatory acceptability of the locally developed Ecological Initiative tool (geospatial data sets integrated at different resolutions) and assess the transferability of this effort to other regions. The C40B2 team applied the tool to specific pilot areas in the region. The two pilot areas include transportation corridors that are under review in one or more aspects by state departments of transportation (DOTs).

The C40B2 team engaged stakeholders at federal, state, and local regulatory and resource agencies. The engagement efforts produced findings that reflect the various levels at which the data are useful in the current state and aspects of the data that would benefit from improvement. The tool, as originally produced, provides state DOTs with useful information to apply in their initial review of a project or a corridor improvement (e.g., the location and extent of ecologically significant areas). However, the initial resolution of this information does not include land cover variation within urban landscapes (e.g., urban trees, open areas, lawns, and parks).

Refinements to the Ecological Initiative tool were made within the pilot areas to provide an improved land cover using finer-resolution input data. The result is an enhanced tool that more accurately reflects conditions on the ground and allows users to see possible impacts at more of a human scale. The opportunities for applying the refined data to corridor studies in heavily urbanized areas are imminent. The Missouri Department of Transportation (MoDOT) is currently developing refined data for the study area of an upcoming I-70 planning and environmental linkages study. Other partners have expressed interest in developing and using this information for watershed planning, green infrastructure planning, and storm water management approaches.

The C40B2 team partnered with the C40A team throughout the development of a national-level web-based tool (Eco-Plan) designed to provide both geographic information system (GIS) users and non-GIS users access to national-level environmental data sets. Eco-Plan consists of two components, Eco-Plan and Eco-Plan Advanced. The C40B2 team conducted beta tests of both Eco-Plan and Eco-Plan Advanced. Beta tests concluded that Eco-Plan would be an excellent way for small-size metropolitan planning organizations (MPOs) and non-regular GIS users at state DOTs to access national-level environmental data sets. Eco-Plan Advanced is targeted toward more advanced GIS users but may not be of great benefit to large size MPOs with robust GIS services. This feedback on the tool was provided to the C40A team.

As in the development of Eco-Plan, the Ecological Initiative tool development and implementation process relied heavily on feedback from experts in the field of natural resource planning and GIS as well as potential users. C40B2 discovered that environmental data needs to be more reflective of conditions on the ground and sensitive to the nuances of natural resource challenges in urban areas. Partnership and perseverance are important to advancing the development of reliable fine-resolution ecological geospatial tools for use in transportation planning and greater conservation and restoration efforts throughout the country.

CHAPTER 1
Introduction

Project Context

In 2008, the East-West Gateway Council of Governments (the Council), the metropolitan planning organization (MPO) for the Saint Louis region, embarked on an innovative process, called the Ecological Approach to Infrastructure Development Initiative (Ecological Initiative). The Council partnered with the Missouri Resource Assessment Partnership (MoRAP) at the University of Missouri–Columbia to expand consultation and to build geospatial tools to be used toward mitigating the impacts of the region's transportation investments on the environment.

MoRAP is a consortium of partners from state and federal agencies and non-government conservation organizations who take a coordinated approach to geospatial data development, analysis, and delivery. Efforts are aimed at improving natural resource management and conservation outcomes. The Council became a formal partner with MoRAP in order to strengthen the Council's ability to develop and integrate ecological planning into the transportation planning process through the Ecological Initiative. The partnership allows the Council to build and strengthen relationships with resource agencies operating in the Saint Louis region.

An extensive network of federal, state and regional/local agencies exists through the partners and affiliates within MoRAP and the governmental relationships established through work at the Council level. This network was instrumental in the development of the regional level ecological geospatial data tool (Ecological Initiative tool). This process identified the area's most ecologically significant natural resources and mapped them in order to better inform transportation planning decisions for the region. The Ecological Initiative tool was applied during the development of RTP 2040, the region's long-range transportation plan, but it has yet to be utilized as a tool for environmental screening at the corridor level for pre-NEPA analysis. The Ecological Initiative tool has the potential to streamline the transportation planning process in the region and advance conservation goals through the availability of quality fine-resolution ecological data.

The region is the home to the confluence of the Mississippi and Missouri Rivers, as well as other river systems, such as the Meramec and the Kaskaskia Rivers. Wetland impacts, especially in the floodplains of these big rivers, are significant environmental issues facing the region. Wetland areas are often included in critical habitat areas for threatened and endangered (T&E) species. Conservation areas in the region are also often included as critical habitat areas. The Ecological Initiative hopes to focus mitigation efforts on wetland locations of greatest restoration potential and identify conservation area expansion and linkage. By doing so, a great deal can be done to enhance conservation efforts in the region.

Proof of Concept Goals

The SHRP 2 C40B2 Proof of Concept (C40B2) is designed to advance pilot studies that implement the products of SHRP CO6A and CO6B and to show how applying a geospatial tool can support integrated ecological planning at the regional and local level. Many practitioners do not have funding to create new information, are unaware of what is available, and do not know how to use available tools. The SHRP 2 C40A project and C40B2 worked together to address this need for access, by creating geospatial tools that will advance the overall goals of the SHRP 2 Capacity focus area. C40B2 provides a means to test acceptance of the Ecological Initiative tool by regulatory and resource agencies as well as to assess the transferability of the tool and the development process.

The Council's partnership with MoRAP carried through to C40B2. The Council and MoRAP (C40B2 team), as co-principal investigators, undertook C40B2 as an opportunity to apply the Ecological Initiative tool into specific study areas. The Council acted as the primary coordinator with the C40A team and the SHRP 2 Project Panel. The Council's staff brought a diverse range of planning expertise and resources in transportation planning; GIS and research services; and environmental planning. MoRAP's staff brought an extensive background in natural resource and conservation planning and expertise in linking remote sensing, geographic information systems, and spatial statistics/environmental modeling to address practical problems in natural resource management, conservation ecology, biogeography, and landscape ecology.

The C40B2 team partnered with the C40A team in the development and testing of the national-level web-based geospatial tool (Eco-Plan). The C40B2 team considered the benefits to MPOs, state DOTs, and natural resource management and regulatory agencies of both the Ecological Initiative tool and Eco-Plan. MoRAP led an internal focus group that provided technical expertise throughout the course of the project and that consisted of technical staff from both MoRAP and the Council. The focus group reviewed and provided input for the development and the beta test of Eco-Plan and collaborated on the data refinement to the Ecological Initiative tool.

Report Structure

The report is organized into five chapters. The first three chapters detail the Ecological Initiative research efforts. Chapter 2 discusses the Ecological Initiative geospatial tool development process, how environmental issues are assessed in the Council's long-range transportation plan, and how the Integrated Ecological Framework (IEF) was followed. Chapter 3 provides an assessment of the Ecological Initiative tool and the proposed enhancements. Chapter 4 details the methodology and the results of the data refinement. Chapter 5 describes the results of the C40B2 team's beta test of the Eco-Plan and feedback on usability and transferability. Chapter 6 discusses the transferability of the Ecological Initiative's geospatial tool development process. And lastly, Section 7 summarizes conclusions from the C40B2 work.

CHAPTER 2
Ecological Initiative Tool Development and Application

Background on Ecological Initiative Tool Development

The Ecological Initiative tool was designed to serve as a central planning tool for linking transportation and environmental decision making. The aim was to provide consistent, accepted information for use by all agencies with jurisdiction in the region in order to facilitate ecological evaluation and mitigation planning. As recommended in the first step of the IEF, "Build and Strengthen Collaborative Partnerships and Vision," the Ecological Initiative worked to develop an understanding among resource agencies about the benefits of working together on a shared vision. Identification and mapping of significant locations for conservation, mitigation, and restoration was the goal. Significant time and energy was spent in consultation meetings with resource agency staff to create a science-based, defensible ecological significance geospatial tool that reflected input from all the resource management and regulatory agencies involved. The agencies and organizations engaged during the course of the Initiative are represented in Table 2.1.

Table 2.1. Agencies and Organizations Engaged During the Initiative

Federal Agencies	State Agencies	Local/Regional/NGOs
U.S. Department of Agriculture Natural Resources Conservation Service Illinois Office Missouri Office U.S. Army Corps of Engineers Saint Louis District Kansas City District U.S. Environmental Protection Agency Region 5 Region 7 U.S. Fish and Wildlife Service Illinois Field Office Missouri Field Office U.S. Geological Survey U.S Department of the Interior National Park Service U.S. Department of Transportation Federal Highway Administration Illinois Division Missouri Division	Illinois Department of Transportation Central Office District Office Illinois Department of Natural Resources Division of Resource Management Illinois Nature Preserve Commission Illinois Environmental Protection Agency Division of Water Missouri Department of Conservation Environmental Compliance Office Regional Office Missouri Department of Natural Resources Division of Environmental Quality Missouri Department of Transportation Central Office District Office	American Land Conservancy Great Rivers Greenway District Heartlands Conservancy Metro East Park and Recreation District Metropolitan Saint Louis Sewer District Metro Transit, Saint Louis Middle Mississippi River Partnership The Nature Conservancy Open Space Council Ozark Regional Land Trust

The coordination and collaboration begun in Step 1 of the IEF resulted in the compilation of data that identifies areas of significant ecological importance for conservation, mitigation, and restoration. As in Step Two of the IEF, "Characterize Resource Status and Integrate Natural Environment Plans," this work provided the data foundation for the mapping necessary for the Regional Environmental Framework (REF). The activity that resulted in the development of Ecological Initiative tool, which includes the land cover, ecological significance, conservation opportunity areas, and wetland mitigation and restoration data layers, is detailed below.

In FY 2010, the Ecological Initiative held technical work sessions with resource agency partners to gather data and conceptualize research methods as summarized in the 2011 MoRAP technical summary titled "Ecological Approach to Infrastructure Development, Final Report." Preliminary concepts, methods, and current vegetation mapping results were presented to partners on three occasions that year. During those meetings, new data sources important to ecological significance were identified, and mapping methods were adjusted. Primary data providers included the Council, the Missouri Department of Conservation (MDC), the Illinois Department of Natural Resources (IDNR), the United States Geological Survey (USGS), and the Natural Resources Conservation Service (NRCS). Partners reviewed initial results at those meetings and provided input to inform adjustments based on professional knowledge of the region. From there, MoRAP mapped the current vegetation in the region, generated an ecological significance model, and established a ranking algorithm. Eight tiers of significance were identified (Figure 2.1).

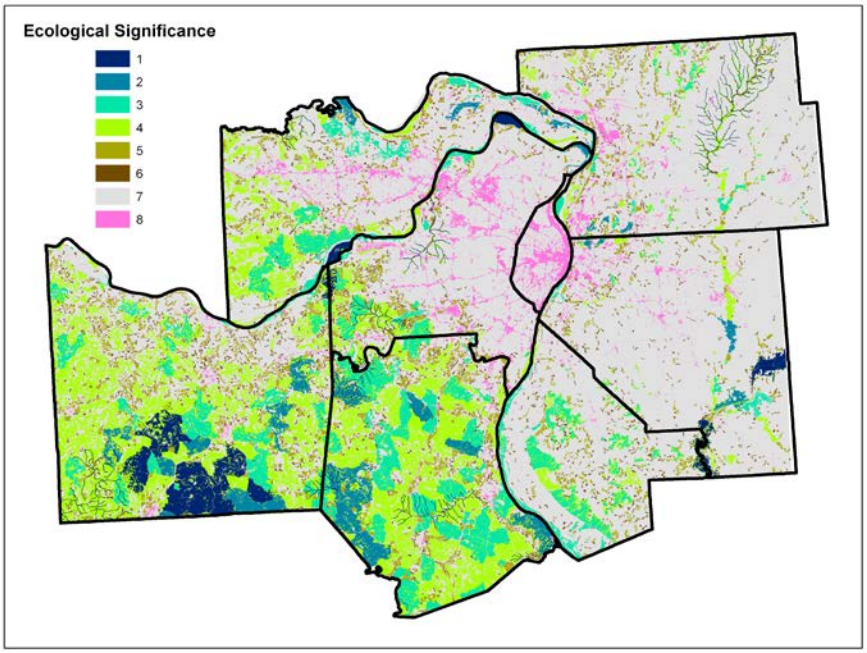

Figure 2.1. Ecological significance for the East-West Gateway region. Significance was assigned to land cover patches based on values for attributes such as size, area of significant natural communities, and number of rare species (MoRAP 2010).

MoRAP made final revisions to this data layer, provided metadata for delivery, and worked with Council staff and resource agencies to explore ways to integrate this information for regional and project-level planning. In addition, MoRAP prepared a finer-resolution, project-level ecological significance data layer for use on a project-by-project basis. The regional ecological significance data layer emphasized the importance of functional landscape patches of semi-natural and natural vegetation, and the results are most appropriate for use when setting priorities on a regional scale. Many project-based decisions must be made at a finer scale of resolution. A project-level ecological significance data layer was developed to address this need.

The Ecological Initiative tool was then integrated into RTP 2040 by mapping the region's transportation projects overlain on data layers from the planning tool to complete the REF, Step 3 of the IEF. The project-level data layer was used in the Project Evaluation Framework, which is comprised of seven criteria ranging from safety and congestion to access and sustainable development. A metric for ecological significance proximity was added to the sustainable development criteria.

The methodology for scoring projects under this new metric entailed overlaying each capacity project on the project-level ecological significance data layer, and generating a ¼-mile and a 1-mile buffer around the centerline of the project. If, during the first step in the evaluation, an area of high ecological significance existed within the ¼-mile buffer, the project received a score of zero for that metric and did not move on to the next step. In the second step, the average

cell classification within the 1-mile buffer is produced and a score is generated with a higher score received for low impact to ecologically significant areas. Figure 2.2 illustrates this scoring procedure.

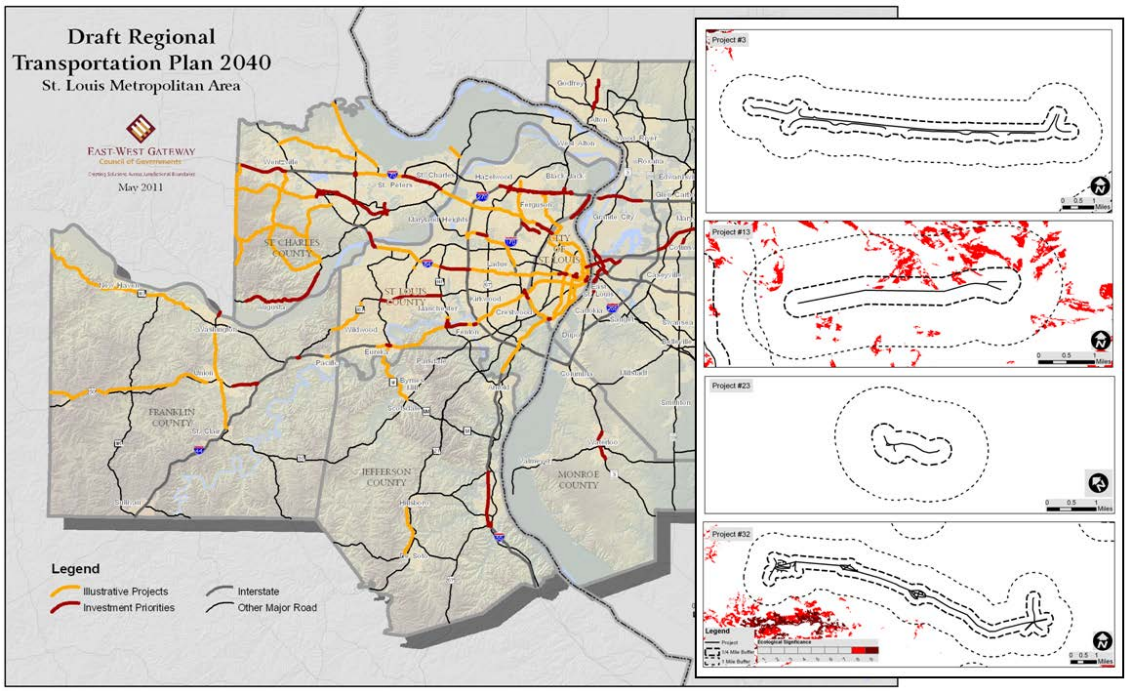

Figure 2.2. RTP 2040 Ecological Significance Project scoring process (E-W Gateway 2011).

The region is unique in that it has used the Ecological Initiative tool in the evaluation of transportation projects for inclusion in RTP 2040. Other components of the Ecological Initiative tool include wetlands data along the fairly extensive Mississippi and Missouri River bottomlands derived from light detection and ranging (lidar) data for mitigation and restoration potential in the region. In the future, the Meramec and Kaskaskia Rivers will be mapped as well. With these enhancements to the Ecological Initiative tool, the region now has an index to regulatory wetlands and a ranking of wetland importance as depicted in Figure 2.3.

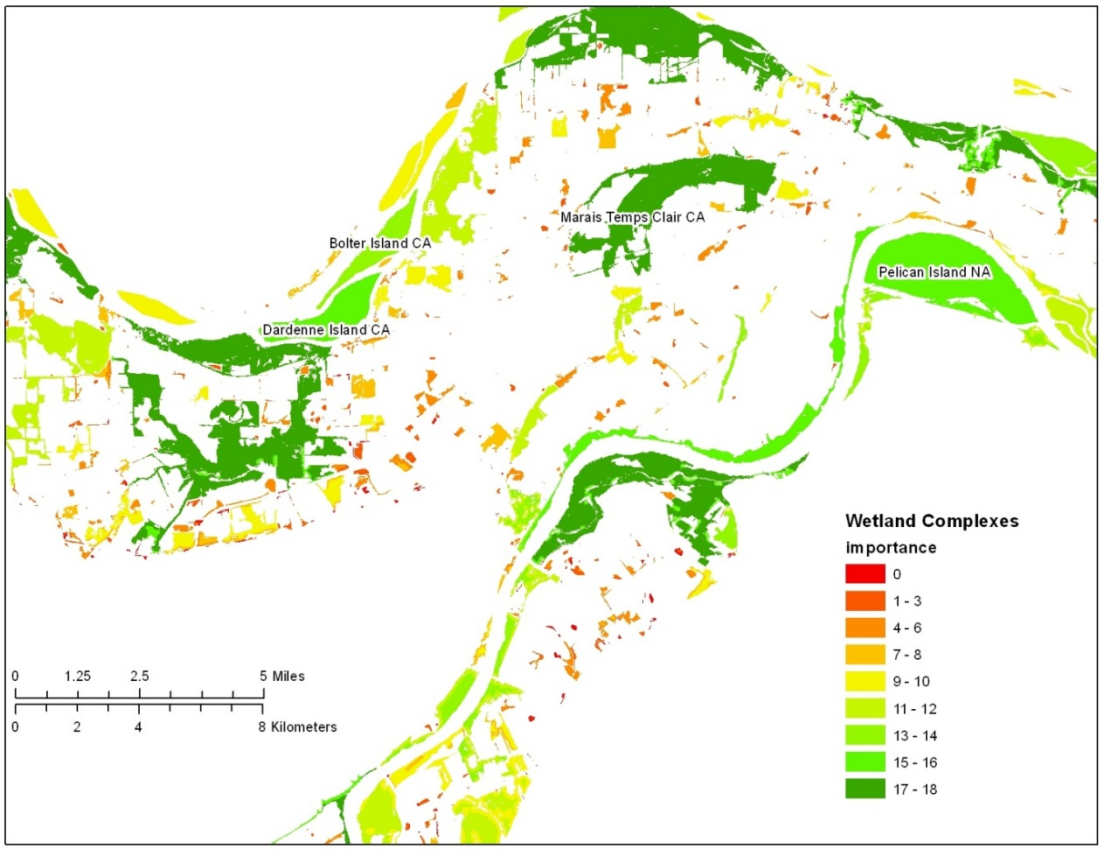

Figure 2.3. Wetland complex importance ranking, Saint Louis region (MoRAP 2013).

In the future, Step 4 of the IEF, "Assess Land Use and Transportation Effects," will be explored. Through the partnership with natural resource agencies, identification of mitigation needs will be made more explicit, and preferred conservation and restoration approaches will be recognized. Ideally, federal and state regulatory and resource agencies will work from the same local data set as they conduct planning activities. Through C40B2, the Council and MoRAP will determine the acceptability of the Ecological Initiative tool by federal and state regulatory and resource agencies for such planning tasks.

Proof of Concept Collaboration Methods

C40B2 seeks to determine if the Ecological Initiative tool is acceptable to all partners, is accessible, and is transferable to other geographic locations. A steering committee comprised of representatives from federal and state resource agencies was established to assist and oversee this effort. The steering committee is comprised of members from United States Army Corps of Engineers (USACE), United States Fish and Wildlife Service (USFWS), Federal Highway Administration (FHWA), Illinois Department of Transportation (IDOT), Missouri Department of Transportation (MoDOT), Missouri Department of Conservation (MDC), Great Rivers

Greenway (GRG) and Heartlands Conservancy, formerly Southwestern Illinois Resource Conservation and Development Council (RC&D). Both MoDOT and IDOT are represented by staff from the District Offices and the Central Offices. The USACE is represented by the regulatory branch and planning division of the Saint Louis District. The USFWS is represented by the Illinois Field Office. . The FHWA is represented by the Missouri and Illinois Division Offices. MDC is represented by the Saint Louis Regional Office.

The kick-off for the steering committee for the C40B project was held in January 2013 at the Council offices. Attendees received background on the SHRP 2 program, the Transportation for Communities—Advancing Projects through Partnerships (TCAPP) website, the C06 work, the Integrated Ecological Framework, and the C40 program. The scope of work for the C40B2 was provided, along with components of the C40A project, and an explanation of how the two are designed to work together. MoRAP provided an overview of the Ecological Initiative tool development, in particular the vegetation land use/land cover data layer, ecological significance data layers, and the wetland mitigation and restoration model. A preliminary discussion was held on the possible pilot areas for the work, with agreement reached that one pilot area should be from Missouri and one pilot area should be from Illinois.

Early in the Ecological Initiative, meetings and discussions focused on the types of data available and methods to be used for the development of the data layers. As part of C40B2 work, the discussions are more directly focused on usability. More direct conversations were had with other partner staff members, as discussed in Section 2. Over the course of the work, a combination of in-person meetings, WebEx calls, email exchanges, and conference calls were used to collaborate with steering committee partners, as well as with individuals from regulatory and resource agencies directly involved in the review and permitting of projects.

The C40B2 team coordinated with the C40A team in a number of ways, primarily via monthly conference calls. Focus group members participated in C40A user group calls and status report updates. In addition to conference calls and the use of Live Meeting technology, a couple of key opportunities for in-person collaboration with fellow C40B proof-of-concept and C40A team members were held.

CHAPTER 3
Data and Methods of Assessment of Ecological Initiative Tool

The biggest hurdle to integrating the Ecological Initiative tool into practice is moving the data to application and testing its acceptability in terms of regulatory decision making. The data have been applied during the development of RTP 2040, but the level of use for corridor review or pre-NEPA analysis is uneven across partners. C40B2 provided an opportunity to put this data into practice to develop a systematic process for streamlining planning and project development in the region.

An assessment was conducted on the methods used and data compiled to develop the Ecological Initiative tool. The assessment identified opportunities and bottlenecks from which strategies were identified on how to further the goals of the Ecological Initiative. This effort helped partners and regulatory agencies identify how and where within their respective institutions to incorporate ecological data tools. By going through this exercise, the regulatory acceptability of the data developed was determined. The assessment provided guidance on additional data needs for partners at all levels and helped to identify next steps to accomplishing those goals. Through this effort, the applicability of the Ecological Initiative tool in other geographic areas and at the national level was evaluated. The assessment began with identifying resource agencies engaged in the early stages of the Ecological Initiative. Table 3.1 lists the agencies involved in the assessment.

Table 3.1. Agencies Involved in the Assessment

Federal Agencies	State Agencies	Local/Regional/NGOs
U.S. Army Corps of Engineers Saint Louis District Kansas City District U.S. Environmental Protection Agency Region 5 Region 7 U.S. Fish and Wildlife Service Illinois Field Office Missouri Field Office U.S. Geological Survey U.S. Department of Transportation Federal Highway Administration Illinois Division Missouri Division	Illinois Department of Transportation Central Office District Office Illinois Department of Natural Resources Division of Resource Management Missouri Department of Conservation Environmental Compliance Office Regional Office Missouri Department of Natural Resources Division of Environmental Quality Missouri Department of Transportation Central Office District Office	Great Rivers Greenway District Heartlands Conservancy Metropolitan Saint Louis Sewer District Middle Mississippi River Partnership

Initial Feedback on Ecological Initiative Geospatial Tool

The assessment process began soon after the development of the REF in 2011, via key resource agency contacts and at an Earth Day symposium attended by state and local governments, consulting firms, and non-profit participants. Feedback on the data reflected interest and enthusiasm for the existence of such a data source that identifies ecologically significant areas. Challenges were noted by users who had attempted to download the Ecological Initiative tool onto their computers but ran into difficulty due to lack of computing power.

The MoDOT Design Bureau reviewed the Ecological Initiative tool in terms of application in the initial planning stages for transportation projects. The agency could see the application of the Ecological Initiative tool in the very early project identification stage. This stage is when the department is learning of transportation needs from local officials for the first time. The Ecological Initiative tool will help the department determine the potential impact of a project early enough in the process to recommend an alternate location or path that would avoid a highly significant area.

MDC reviewed the Ecological Initiative tool in terms of its potential to identify greenspace in the City of Saint Louis, primarily in the area from downtown to the northern city limit. Over the past two decades, a significant number of lots have been cleared of structures and are currently vacant. MDC was researching the potential of vacant land in the city to be repurposed or reverted back to the natural system that existed predevelopment and/or converted to greenspace and greenways.

Applying the Ecological Initiative tool to a local green infrastructure project in an urbanized area pointed out one of the limitations of the data. Classes of urban land cover recognized at intermediate resolution by previous efforts actually contain green space (e.g., urban parks, narrow river corridors that are not developed, and so on) that was not mapped. Also, impervious surfaces were not separated from lawns and trees at fine resolution in urban areas. Some very large parks and cemeteries were mapped as areas of moderate ecological significance, but for the most part, the City of Saint Louis, Saint Louis County, and developed areas of Saint Charles and Saint Clair County were mapped as being of low ecological significance without distinguishing differences between narrow greenways and parks versus heavily developed areas.

Regulatory and Resource Agency Feedback

The C40B2 team conducted phone interviews with regulatory and resource agency staff members in February 2013 to determine planning and project review procedures within each agency, with an eye toward how the Ecological Initiative tool could be incorporated. The following is an agency-by-agency summary of phone interviews (Table 3.2).

Table 3.2. Agency Feedback on the Ecological Initiative Tool

Agency	Project Review Process/Feedback on Ecological Initiative Tool
Missouri Department of Natural Resources (DNR)	Public notices are received by and reviewed at the director level, then directed to the appropriate programmatic area, such as water quality, air quality, hazardous waste, parks and trails, etc. The agency is dependent upon in-house data sources and GIS tools. With projects of a significant size, the Missouri Interagency Review Team (IRT) gets involved in the review. The Missouri IRT is composed of representatives from the USACE, DNR, USFWS–MO, MDC, U.S. Environmental Protection Agency (U.S. EPA), and USDA/NRCS. MDNR staff determined that the Ecological Initiative tool has the greatest value for stream and wetland impacts. State and federal agencies are trying to identify new sites for wetland banks, and the tool could help identify those sites.
Missouri Department of Conservation (MDC)	Public notices are issued by USACE about projects that appear to have impacts and MDC provides comments. MDC has Clean Water Act review authority as well as endangered species and wetlands review and uses USFWS Critical Habitat designation data, Heritage (Biological and Conservation Database) information, department-defined Conservation Opportunity Areas, and data sets from a variety of other sources to complete reviews. MDC staff sees value in the Ecological Initiative tool because it is locally and regionally specific. MDC reviews are GIS-based, so the geospatial data tool could be easily incorporated into their review. The Ecological Initiative tool could help guide the IRT Wetland Review and could help guide mitigation to priority areas.
Great Rivers Greenway (GRG)	GRG sees the Ecological Initiative tool incorporated into the organization's greenway planning and specifically work related to the Meramec Greenway. Refinements to the tool that better reflect the undeveloped, parkland, and green buffer areas along the routes of existing and proposed greenways in the region would be beneficial to the agency.
USFWS–IL	The agency reviews projects for impacts on fish and wildlife per the Fish and Wildlife Coordination Act (FWCA) and associated requirements of Section 404 of the Clean Water Act. IDOT sends a Biological Resources Review (BRR) to USFWS in cases of a potential impact. For wetland reviews, USFWS typically uses Google Earth, the National Wetlands Inventory (NWI), and occasionally Middle Mississippi River Partnership wetland mapping data. The Ecological

	Initiative tool would be a good additional data source for their review.
USFWS–MO	Project review (exclusive of endangered species review) focus involves projects impacting waters of the United States. The wetland and stream assessment program guides the agency's review. The Ecological Initiative tool would be a good additional source for project review. The Ecological Initiative tool would be useful in identifying good locations for wetland restoration in the region.
U.S. EPA Region 7	The agency enforces the provisions of Section 404 of the Clean Water Act (CWA) and reviews and comments on permit applications. NEPA Assist is used for project review. Given the national scope of NEPA Assist, it is not likely the Ecological Initiative tool could be added to NEPA Assist. The Ecological Initiative tool could be incorporated as one of the commonly used data sets the agency uses in its reviews and project mitigation.

Data Assessment Meeting

On March 7, 2013, a data assessment meeting was held to discuss the Ecological Initiative tool. The goals were to discuss the usability of the tool and what could be improved. The group discussed data delivery mechanisms, the usability/applicability of the tool, how the data can address environmental issues pre-NEPA, what strategies and data sources should be pursued in the future, and what other geographic areas benefit from the local process. Individuals from federal, state and local resource, regulatory, and planning agencies were in attendance. Many of the individuals were participants in the data sharing and development of the Ecological Initiative tool. Below is a summary of input received from workshop attendees (Table 3.3).

Summary of Bottlenecks and Opportunities

Data Accessibility

The Ecological Initiative tool has established priority ecological areas in the region. Given the methodology that was followed and the data sources used, regulatory and resource agencies recognize the validity of the designations and the ranges of ecological importance. Agencies have, within their organizations, data sets and tools that are used in planning and project reviews. However, these data are typically statewide data sets. Having a data set unique to the Saint Louis region is helpful in identifying priorities in the region.

Table 3.3. Summary of Feedback from Assessment Meeting

Topic	Summary of Input
Project Development/Project Review	Project sponsors should use the Ecological Initiative tool early in the project development process in order to avoid significant areas. At the NEPA and permit review stage, agencies are asked what impacts there are, not where a project should go. In this sense, environmental review is reactive. Agency staff members are not always involved early enough in the process to have maximum influence. During the permitting process, IDOT uses the Illinois Department of Natural Resources (IDNR) Ecological Compliance Assessment Tool (EcoCat) to determine project impacts. IDOT also uses the IDNR Detailed Impact Review Tool (DIRT) database.
Mitigation Banks	The Ecological Initiative tool would be useful in identifying potential wetlands banks and should be made available to potential bankers. When a mitigation bank application is made, the location has already been identified and is likely under the banker's ownership already. Bankers work most closely with USACE. USACE typically uses an ecosystem approach to siting a bank. There are a few active bankers in Missouri and there are banks available in Illinois as a result of the construction of the I-70 Stan Musial Veterans' Memorial Bridge. MoDOT is not doing a lot of banking right now due to the state's funding situation. Part of the mitigation permit review in Missouri follows the Missouri Stream Mitigation Method. A banker can build a bank but can't sell credits until it has been approved.
Wetlands Data	More extensive mapping of other waterways in the region such as the Meramec River and the Kaskaskia River is desirable, but funding for such work is limited. Lidar is available for most counties in the region. USGS is pushing a 7-year cycle for lidar updates. The USACE sees the potential for the Ecological Initiative tool to be used to prioritize projects on a large scale and could potentially be useful for the regulatory side of the agency, to prioritize locations in watersheds.
Local Land-Use Planning	While the Ecological Initiative tool was developed at a regional scale, it can be beneficial to local governments in identifying locations for conservation and restoration. The benefit of the data lay in governmental agencies and land conservancies proactively identifying locations and coordinating activities to preserve, mitigate, or restore those areas. Use of the data in the City of Saint

	Louis and County is hampered by current land cover classification that shows the majority of the area as urban high intensity or urban low intensity. Greater ecological diversity is present but not represented.
Local/Regional Agency Needs	Heartlands Conservancy has a seven-county region; only three of the seven are in the Saint Louis region. The agency would like to see the Ecological Initiative tool extended to other watersheds in counties outside the Saint Louis region. The agency is conducting a green infrastructure plan for Southern Illinois to address stormwater, nodes, and future green space connectivity. Agency recommends considering future grant opportunities to expand wetlands data. MDC could apply the Ecological Initiative tool in locations such as the Confluence of the Missouri and Mississippi Rivers. The agency is interested in seeing the tool refined to aid in the restoration of green areas in the urbanized area, such as in the City of Saint Louis, where there is a need to rebuild green infrastructure.
Accessibility of the Tool	Making the Ecological Initiative tool widely available and readily usable by everyone is challenging. Computing capabilities vary from organization to organization. In some organizations, GIS software is not available. ArcView tools such as ArcViewer and ArcReader could be options for agencies without ArcView software. The tool does not have a dedicated online location for easy access. Availability on a web portal or similar site would be beneficial. The Missouri Spatial Data Information Service (MSDIS) is developing "clip and ship" for lidar data hosted on its website.

While the Ecological Initiative tool has been distributed widely via flash drive, there are still many potential users who will need access. In order for the tool to be widely used, project developers will need access to the tool for application in the early planning stages. File size, legacy file formats, and software version variations across agencies create some challenges with sharing the data layers. For example, the underlying land cover data layer contains 1.1 million polygons in more than 60 categories. A file of this complexity is better suited to storage in a geodatabase than a shapefile, but several agencies prefer to work with shapefiles to avoid conflicts with geodatabase/software versions. As a zipped shapefile, the land cover layer is 1 gigabyte. Unzipped, it is almost twice that size. The file size creates challenges for agencies to download/upload the data. Clipping the data down to a small study area is the ideal solution for desktop users, but it requires very long processing times and requires significant processing capacity.

An option to improve the availability of the Ecological Initiative tool is to post the tool on the Missouri Spatial Data Information Service (MSDIS) website. MSDIS is housed within the Geographic Resources Center at the University of Missouri–Columbia and maintains a data portal and provides access to vast amounts of GIS data. A variety of GIS data is available on the publicly accessible site for free, but a fee is charged for some web services. MSDIS is developing and testing an automated "clip and download" technology. If the developers of the MSDIS site are successful with their prototype, the possibility exists that the same technology could be applied to the Ecological Initiative tool in the event it is made available on the site.

Existing Land Cover Classification

Currently the vast majority of Saint Louis City, Saint Louis County, and portions of Saint Charles County and Saint Clair County are classified as urban low intensity/urban high intensity. The maps do not segment out urban greenspace versus impervious cover. Hence, the ecological impact of a vast majority of projects appears identical (i.e., all occur in urban land cover) and low (i.e., no ecologically significant areas are impacted). A large number of federally funded transportation projects occur within the urbanized area of the region. When the Ecological Initiative tool was developed, the intention was for use at the regional scale. Users in urban areas need finer-resolution information.

This challenge becomes evident when attempting to apply the data within the urbanized area of the region. While some greenspace is mapped in the urbanized matrix area portion of the Ecological Initiative tool, such as Forest Park and Calvary Cemetery, other existing greenspace could be depicted better. For example, greenways and green infrastructure are being actively promoted and developed in the region to address stormwater needs and to enhance greenspace connectivity. Greenway planning that seeks to promote healthy, active lifestyles contributes to the overall health of the region; the preservation and linking of these corridors could facilitate the restoration of waterways and related wetland environments they typically follow. Greenway planning, watershed planning, and stormwater Phase II planning would benefit significantly from data tools that identify viable areas for conservation or restoration.

Proposed Enhancement of Ecological Initiative Geospatial Tool

Of the issues identified in the assessment, the improvement in land cover mapping resolution proved to be the primary concern and was therefore addressed by the C40B2 team. Fine-resolution data were acquired and analyzed to address needs. This method involved acquisition of the fourth band of the Council's 2012 orthoimagery imagery. Orthoimagery typically has four spectral bands: red, green, blue, and infrared. The Council currently has three spectral bands (red, green, blue) that were processed from the raw data flown in 2012. Three-band imagery gives the appearance of natural color, which is sufficient for uses that do not require the differentiation of vegetated versus un-vegetated surfaces. Color-infrared (CIR) orthoimagery facilitates the identification of impervious features by showing the difference in spectral

reflectance between natural vegetation and un-vegetated surfaces. The fourth band, the near-infrared portion of the raw data, is needed (together with lidar data) to develop fine-resolution maps of urban areas.

Transferability of the Ecological Initiative Geospatial Tool

There are three key areas of application of the Ecological Initiative tool: project planning and pre-NEPA analysis, wetland mitigation and restoration, and local and regional planning. The insights obtained through this analysis highlight lessons learned that are transferable to other geographic areas developing and implementing ecological geospatial tools (Table 3.4).

Table 3.4. Lessons Learned and Insights in Transferability

Key Applications of the Ecological Initiative Tool	Lessons Learned/Insights into Transferability
Project Planning/Pre-NEPA	State DOTs and local project sponsors need to have access to the Ecological Initiative tool early in the planning process at the initial decision-making stage. Being able to plan around ecologically significant areas will go a long way toward protecting key areas. The intent of the tool is to enhance conservation while improving project delivery and reducing cost. If the project sponsor has to go back and adjust the project design, that will add time and cost to the project. Data availability and accessibility are critical. Access to the tool via a publicly accessible website for a wide range of users will address this significant access issue.
Wetland Mitigation and Restoration	The Ecological Initiative tool is instrumental in the identification of future wetland mitigation and restoration areas in the region. The tool provides regulatory agencies the data needed to proactively identify mitigation sites. The tool, when made available to wetland bankers, will guide future locations. Regulatory agencies cannot dictate the location of wetlands banks, but the marketplace that guides the siting of banks can be informed by the tool.
Local/Regional Planning	Agencies with small staffs and limited resources and capacity in the areas of GIS skill levels and computer technology may encounter difficulty accessing the Ecological Initiative tool. Lack of ArcGIS and other GIS viewing software as well as hard drive, RAM, and server space can be a constraint. Once the data are downloaded, the user has to be able to manipulate the data and load additional shapefiles related to the project area being reviewed.

The assessment of the Ecological Initiative tool provided the C40B2 team with feedback from key individuals from regulatory and resource agencies that will help advance the tool's application in pre-NEPA planning, wetlands planning, and local and regional planning.

CHAPTER 4
Enhancements to Ecological Initiative Geospatial Tool

The assessment indicated the need to refine the Ecological Initiative tool to extract a finer-resolution land cover, including impervious surfaces, in the area identified as urban low intensity and urban high intensity in the existing classification. The goal of the tool refinement is to identify the softscape amidst the urban landscape, to map green corridors and nodes that, while they have likely been impacted by urbanization, still contribute to the ecological health of the region. The original tool contained data developed mainly for planning outside of core urban areas, whereas the new data are focused for use inside of core urban areas.

As use of the Ecological Initiative tool expands to partner agencies and beyond, a broader range of user needs is emerging. Partners are interested in using the data for green infrastructure planning and site review activities, in addition to regional scale planning. Two pilot project corridors were identified as the location to test the development and applicability of finer-resolution land use and land cover (LULC) information.

Two pilot study areas were selected to develop a fine resolution LULC data set. These study areas were I-44 in southwestern Saint Louis County, Missouri, and IL-158 in Central Saint Clair County, IL (Figure 4.1). These study areas circumscribed a diverse mix of cover types and urban densities and thus facilitated the evaluation of the usefulness of the improved spatial resolution LULC in assessing potential environmental impacts. The I-44 study area was approximately 25 square miles in area, and included portions of the municipalities of Crestwood, Fenton, Kirkwood, Peerless, Sunset Hills, and Valley Park. The I-44 study area had a diverse mixture of cover types including forested state park lands, industrial, high density urban, and low density urban. The IL-158 study area was approximately 48 square miles in area and included portions of the municipalities of Millstadt and Columbia within its boundary. Cover types in the IL-158 study area were mostly agricultural, with some low density urban.

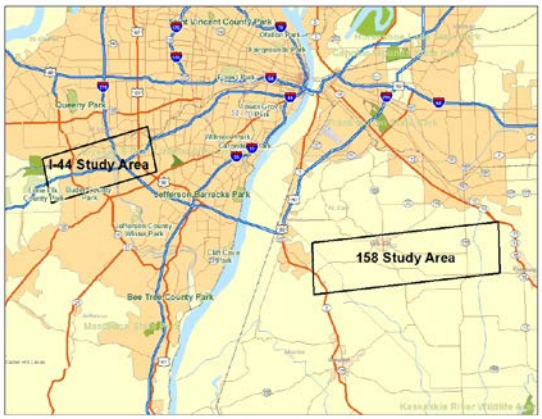

Figure 4.1. Study areas I-44 in Southern Saint Louis County, Missouri, and IL-158 in Central Saint Clair County, Illinois.

Data Enhancements

Spring 2012 Lidar

To obtain a highly accurate depiction of landscape terrain, as well as vegetation and building structure height to aid in LULC mapping, a digital elevation model (DEM) and digital surface model (DSM) were developed for each study area from raw lidar LAS points at 1-meter spatial resolution. Lidar is an optical sensor that measures distance through multiple laser pulses, thus allowing a user to determine the elevation of the surface and the height of objects on the ground by comparing multiple pulse returns. For the IL-158 study area, lidar data were acquired from March 26 to April 2, 2012, for the Illinois State Geological Survey (ISGS) and have a fundamental vertical accuracy (FVA) of 12.5 centimeters. For the I-44 study area, lidar was collected January 29 to 30 and February 1, 2012, by Surdex Corporation for the United States Army Corps of Engineers (USACE) and has a FVA of 18.5 centimeters. All lidar data were downloaded from the state of Missouri lidar data clearinghouse hosted by Washington University in Saint Louis (ftp://lidar.wustl.edu/).

QT modeler software was used to process LAS files for both study areas. The DEM (Figure 4.2) was generated using a grid sample of 1 meter. Adaptive triangulation was used to interpolate elevation in areas where points were less dense, with a maximum distance between points and maximum triangle side of 1000 feet for surface interpolation. The mean *z* (height) value for each point was calculated for points with class values of 2 (ground) and 8 (model key points). The DSM (Figure 4.3) was generated using a grid sample of 1 meter and adaptive triangulation with a maximum point distance and maximum triangle side of 1000 feet. The maximum *z* value for first returns was used to obtain the tallest possible point of vegetation or structures.

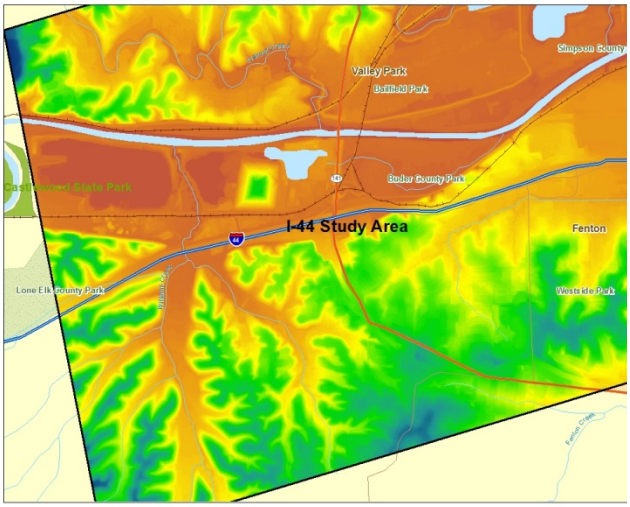

Figure 4.2. Digital elevation model (DEM) from lidar LAS points (MoRAP 2014).

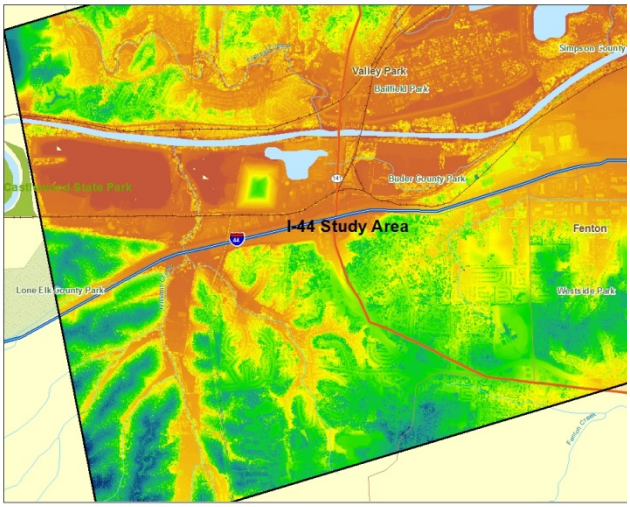

Figure 4.3. Digital surface model (DSM) from lidar LAS points (MoRAP 2014).

Vegetation and structure height (Figure 4.4) was created by subtracting the DSM, which is the highest point on the surface, from the DEM, which is the lowest point on the surface. The vegetation/structure height data set provides vegetation and structure (building, bridge, utility pole, etc.) height of features on the surface within the study area. Height information of cover types is valuable to the LULC modeling approach.

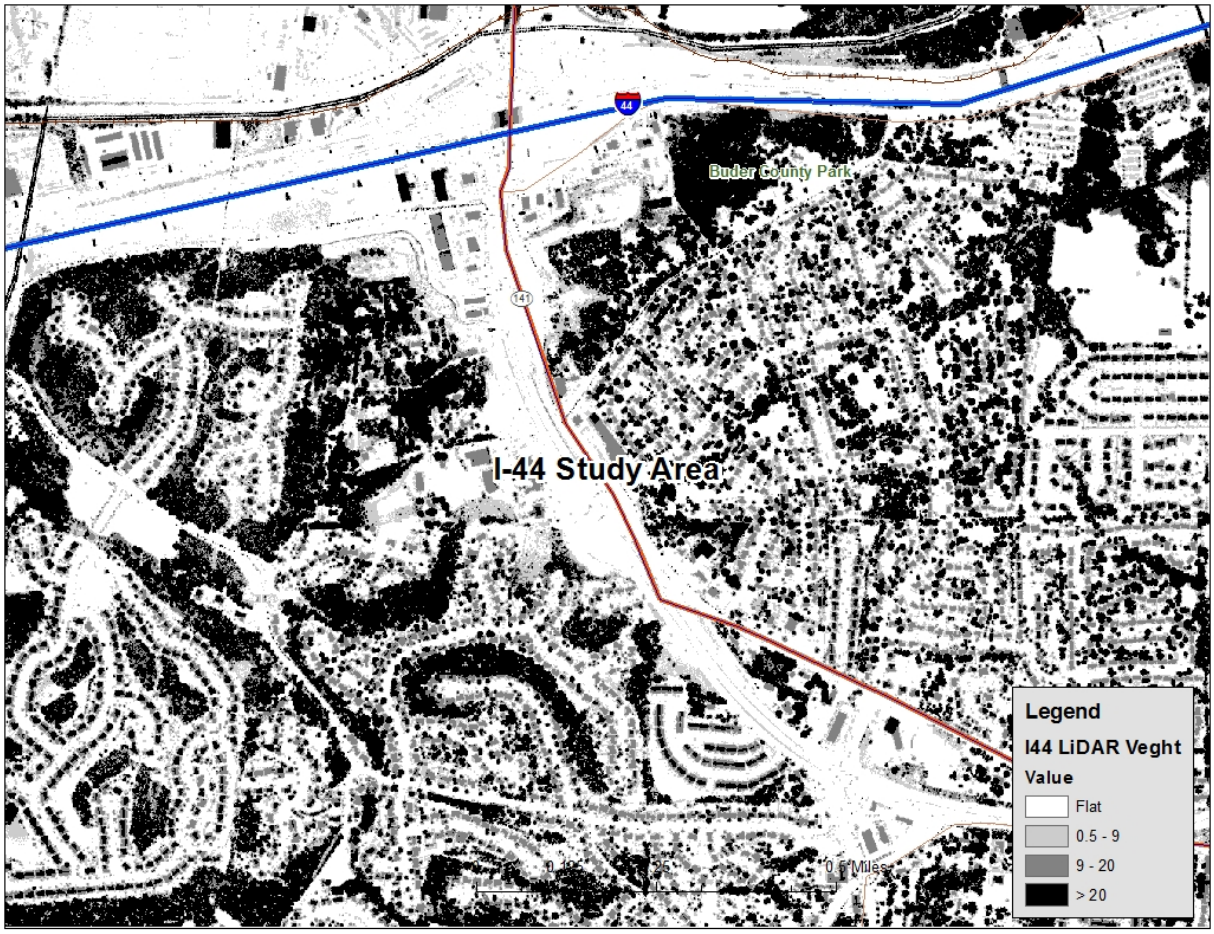

Figure 4.4. Vegetation and structure height surface developed by subtracting lidar DEM from DSM (MoRAP 2014).

Additional lidar-derived products such as slope, aspect, solar insolation, and land position were created based on the DEM for each study area. These products provide surface information explaining various landscape variables. LULC classes were defined via a supervised classification using these and other variables (see below).

2012 Aerial Photography

Aerial photography from spring and summer 2012 was used to aid in LULC mapping for both study areas. The use of multi-temporal imagery to classify LULC allows for improved classification of forest, grass, and agricultural classes by differentiating spectral changes in vegetation senescence and canopy density between seasons. Leaf-off (spring) imagery reveals structures hidden below the canopy of summer (leaf-on) imagery, which would otherwise be missed in mapping (Figures 4.5 and 4.6). It is uncommon to have high-resolution multi-temporal

imagery for a given location within the same calendar year. The use of this imagery allowed for an accurate classification of surface cover conditions as of summer 2012.

Spring 6-inch, leaf-off, 4-band, false color-infrared imagery (Figure 4.5) was sampled to 1-meter spatial resolution to match the spatial resolution of the summer United States Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP) imagery. The addition of the infrared band helped especially in separating grassland from cropland. Summer 1-meter, leaf-on, 3-band true color NAIP imagery (Figure 4.6) was downloaded for both study areas from the USDA NRCS Geospatial Data Gateway (datagateway.nrcs.usda.gov/).

Figure 4.5. Spring 2012, 1-meter, leaf-off, 4-band infrared imagery aided in mapping of grass and crops and well as structures hidden below the forest canopy (MoRAP 2014).

Figure 4.6. Summer 2012, 1-meter, leaf-on, 3-band imagery used to map LULC (MoRAP 2014).

Metropolitan Sewer District of Saint Louis Impervious Surface Data

Metropolitan Sewer District of Saint Louis (MSD) impervious surface geographic information system (GIS) polygon data, created in 2009, was supplied by East-West Gateway to aid in LULC mapping of impervious surfaces. The MSD impervious surface data include polygons of various impervious surface structures at a fine resolution, including the footprints of houses, sidewalks, sewer drains, and parking lots (Figure 4.7). The use of this data improved mapping of roads, parking lots, sidewalks, and building footprints. MSD only covers a small geographic area of the Saint Louis region, including Saint Louis City and Saint Louis Counties in Missouri. As a result, MSD data were only applicable for the I-44 study area.

Figure 4.7. MSD impervious surface polygons aided in mapping roads, building footprints, and other impervious surfaces for the I-44 study area (MoRAP 2014).

Results of Enhanced Tool Applied to Pilot Areas

LULC Classification

A two-date multi-temporal aerial photography data set, together with lidar-based DEM-derived variables, was used to generate a fine resolution (1 meter) LULC data set, current as of June 2012. A supervised classification and regression tree (CART) modeling approach was utilized to classify six LULC classes based on 600 spatially explicit photo-interpreted ground samples for each study area.

Samples

A stratified random selection of 100 samples per target LULC class (water, urban/impervious, barren, forest, grass, and crop) was generated based on the 15-class, 30-meter resolution 2008–2009 MoRAP LULC, resulting in a total of 600 training samples per study area (Figure 4.8). The

training sample points were used to inform the classifier and produce a six-class LULC map. The original 15 LULC classes were aggregated to fit within the six mapped classes (Table 4.1). The points were manually inspected against the 2012 aerial photography to verify that each point represented the cover type it was assigned to. In the event that a point did not represent the cover type it was assigned to, the point was deleted.

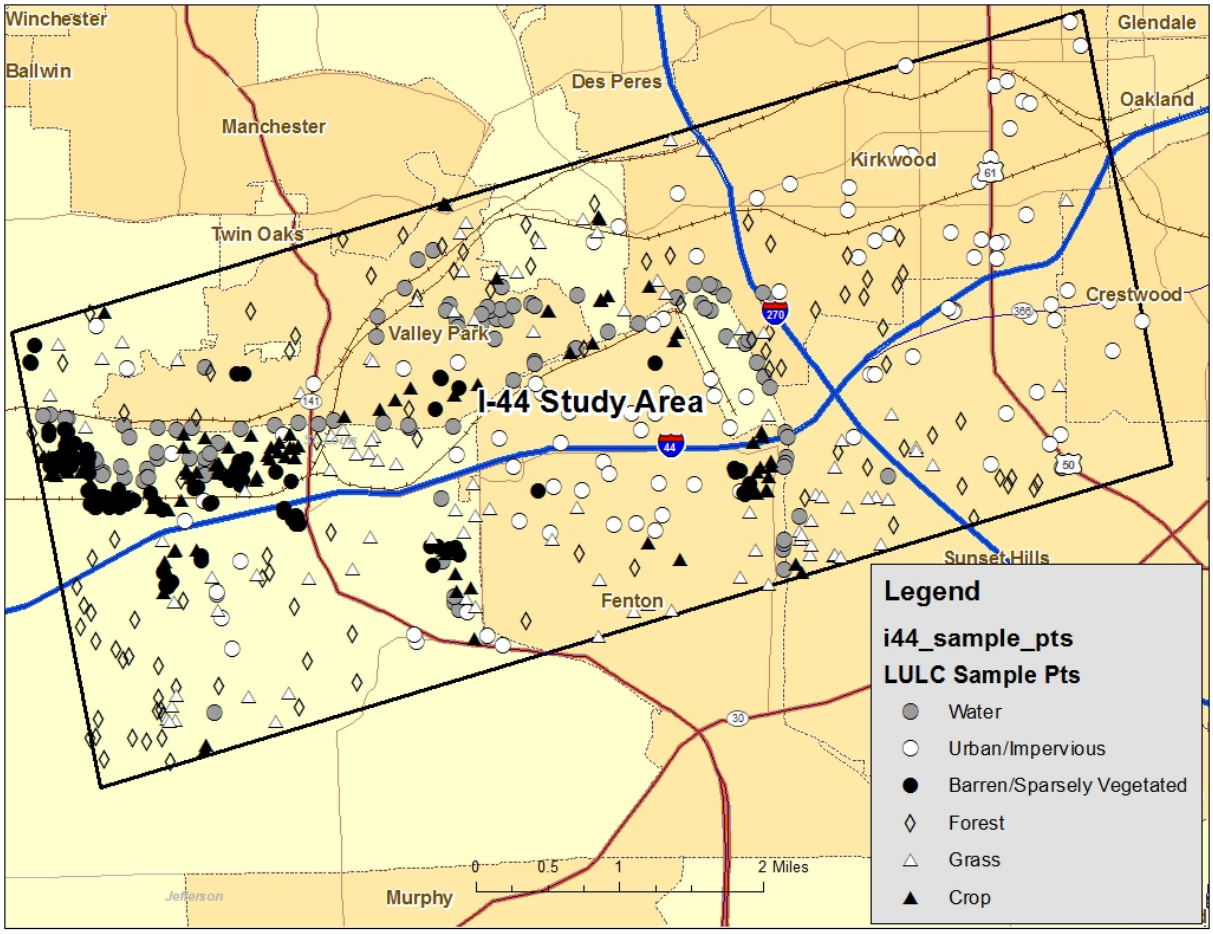

Figure 4.8. LULC training samples within the 158 study area (MoRAP 2014).

Table 4.1. Crosswalk of 15-Class LULC Used to Generate Training Samples and Six LULC Classes to be Mapped for this Project

6 Class LULC to be mapped for 2012	2008-2009 15 Class LULC
Water	Open Water
Urban/Impervious	Impervious
	High Density Urban
	Low Density Urban
Barren/Sparsely Vegetated	Barren or Sparsely Vegetation
Forest	Deciduous Forest
	Evergreen Forest
	Mixed Forest
	Deciduous Woody/Herbaceous
	Evergreen Woody/Herbaceous
	Woody-Dominated Wetland
Grass	Grass
Crop	Crop

Modeling

Six classes were mapped at 1-meter spatial resolution using a supervised CART modeling approach with boosted regression trees with See5 statistical software. The classes that were mapped are:

1. Water
2. Urban/Impervious
3. Barren/Sparsely Vegetated
4. Forest
5. Grass
6. Crop

Approximately 600 spatially explicit sample points were used to map LULC based on the statistical relationship of 14 spectral and terrestrial landscape-based variables, including 2012 aerial photography (seven total bands from two dates of imagery), vegetation height, digital elevation model, digital surface model, slope, aspect, solar insolation, and landscape position. The model produced a six-class, 1-meter raster LULC for each study area (Figure 4.9).

Figure 4.9. Six-class, 1-meter supervised LULC in the158 study area. (MoRAP 2014)

Objects

In order to create a vector-based LULC classification, which is valuable for querying specific cover types and improving the resolution and detail of LULC classification, image objects were generated. Image objects are polygons that circumscribe statistically homogeneous features on the landscape based on input data sets using eCognition software. Image objects for this project were generated based on lidar-derived vegetation/structure height and 2012 leaf-on and leaf-off imagery. The modeled six-class, 1-meter raster LULC was used to assign objects LULC values by summarizing the majority of the LULC pixels within each object (e.g., the mode land cover value from pixel centroids was assigned to each image object polygon; see Figure 4.10).

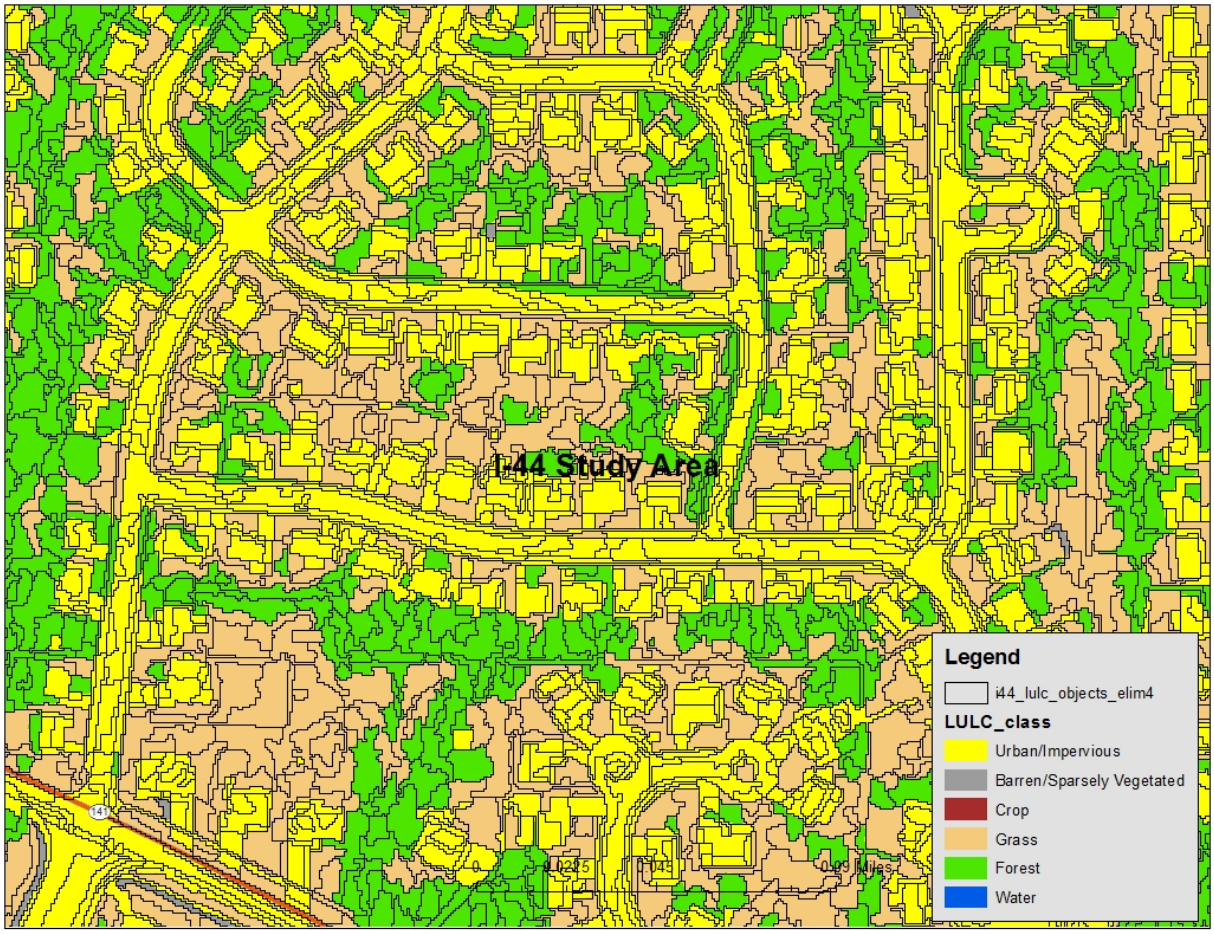

Figure 4.10. Objects (black) were populated with LULC by summarizing the majority of LULC pixels within a polygon. (MoRAP 2014)

Manual Inspection

After image objects were assigned LULC values based on raster classification, they were visually inspected for classification errors. The polygons were compared against vegetation height and the 2012 leaf-off and leaf-on aerial photography data sets. When errors were found, the polygon was assigned to the appropriate class. Errors were inspected and manually edited at a scale of 1:1500 to 1:2000. Common errors included misclassification of shadows around buildings and at the edge of forests as water, grass as crop, and buildings as forest (Figures 4.11 and 4.12). Manually inspecting objects for errors was the most time-consuming aspect of the project. One could reduce the time spent on error correction by editing at a coarser scale (i.e., 1:5000) and/or increasing the minimum size of image objects so that there are fewer objects and details to correct. Overall cross-validated accuracy before editing for the I-44 study area was 79.5%, and was 81.1% for the IL-158 study area.

Figure 4.11. Building shadows mapped as water was a common error fixed by manual inspection (MoRAP 2014).

Figure 4.12. The 2012 leaf-off aerial photography was used to identify and correct mistakes, such as building shadows being mapped as water (MoRAP 2014).

Post-processing/Filtering

After objects were inspected for errors, polygons less than or equal to 4 square meters were eliminated and absorbed by the adjacent polygon sharing the longest border to reduce the number of small polygons within the data set. Objects were then dissolved to aggregate adjacent polygons with the same LULC class to clean up and reduce the number of polygons in the data set (Figures 4.13 and 4.14).

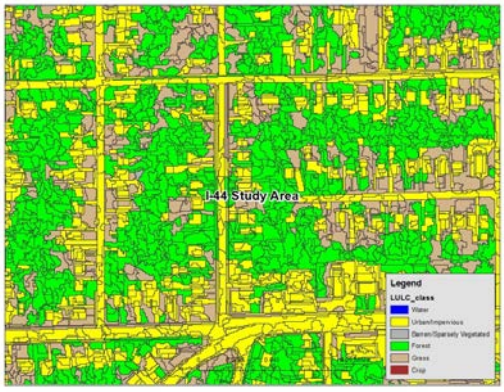

Figure 4.13. Undissolved image objects in I-44 study area (MoRAP 2014).

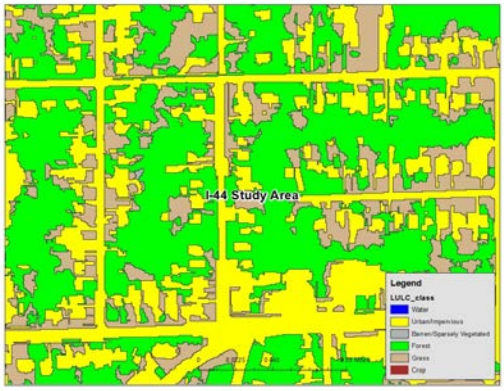

Figure 4.14. Dissolved objects in I-44 study area aggregates adjacent objects with same LULC type into a single polygon. Reduced number of polygons from 546,931 to 44,276 in I-44 study area (MoRAP 2014).

Success and Challenges

The 2012 1-meter, six-class LULC improved upon the detail of LULC mapping that previously existed in the Saint Louis region by using higher spatial resolution imagery and lidar data, yet reducing the thematic resolution. The goal of improving the mapping of urban vegetation and riparian corridors within the metro area was achieved (Figures 4.15 and 4.16). The comparison in overall LULC composition between the 2008–2009 30-meter LULC and 2012 1-meter LULC shows that, in a more diverse and urbanized landscape, the mapped LULC composition would be significantly different than that of a more rural, natural, and homogeneous landscape. In the more urbanized I-44 study area, mapped LULC composition changed dramatically, with the 2012 LULC mapping half as much urban/impervious and twice as much grass and crop than the 2008-2009 LULC (Figure 4.17). In the less urban and more agricultural 158 study area, the 2012 LULC mapped two-thirds-percent less urban, 10% more crop, 8% more forest, and 9% less grass than the 2009-09 LULC (Figure 4.18). The use of higher resolution imagery in mapping the 2012 LULC allowed for a more detailed depiction of all cover types, which can provide a more accurate analysis of the impact of potential development when incorporated into the environmental impact model.

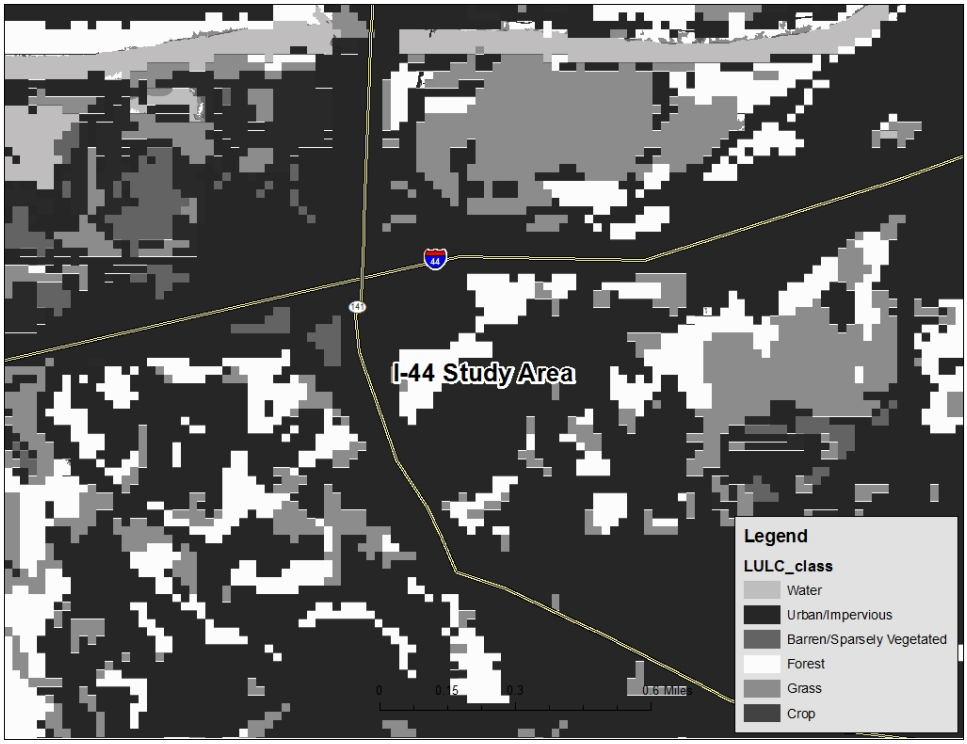

Figure 4.15. 2008-2009 MoRAP 30 meter LULC in I-44 study area (MoRAP 2014).

Figure 4.16. 2012 MoRAP 1-meter LULC in I-44 study area (same extent as Figure 4.15) shows improved detail in urban vegetation and impervious cover mapping (MoRAP 2014).

Acceptability of the Data Refinements

Upon completion of the work, the C40B2 team set about to determine the regulatory acceptability of the refined land use/land cover classification. The results of the data refinement were presented to members of the steering committee in February 2014. The background behind the data and the advanced techniques required to produce the data refinements were discussed. Participants contributed insights on how the data can be applied to work within their agencies.

The methodology behind the 2012 1-meter LULC classification was widely accepted as a certified approach to refining the 2008–2009 30-meter land cover. It was clear to members that, while the 2008–2009 30-meter land cover proved useful for earlier work, in the 2012 1-meter LULC classification, the fine-resolution six LULC cover class product gives the end user more reliability when using the data for planning activities. The 1-meter LULC provides a much more accurate picture of conditions on the ground. The new LULC provides an improved picture of possible impacts a transportation project can have on the environment, particularly in urban settings, and would be useful to DOTs by providing better site-specific information when corridor studies were conducted and projects occurred in urban locations. The data provide a much better visual depiction of information contained in national data sets, as well as conditions on the ground that are not contained in national-level data.

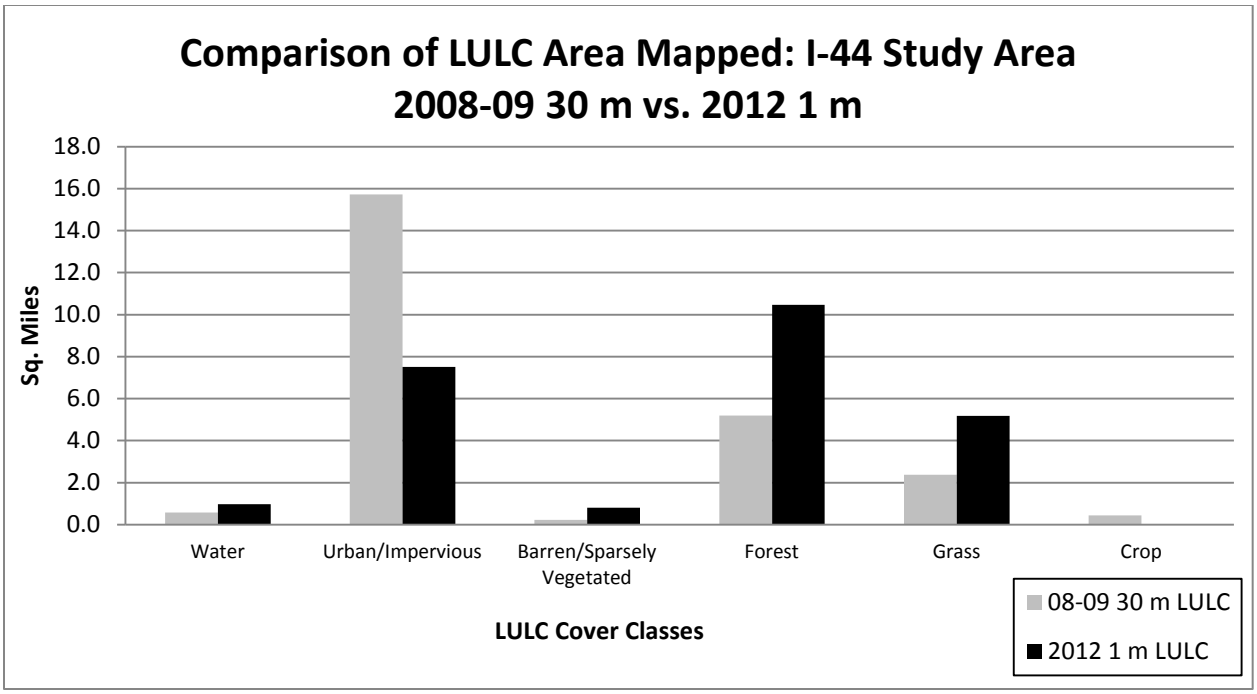

Figure 4.17. Comparison of LULC composition mapped of 2008–09 30-meter LULC and 2012 1-meter LULC in I-44 study area. Improved spatial resolution resulted in significant changes in LULC composition mapped.

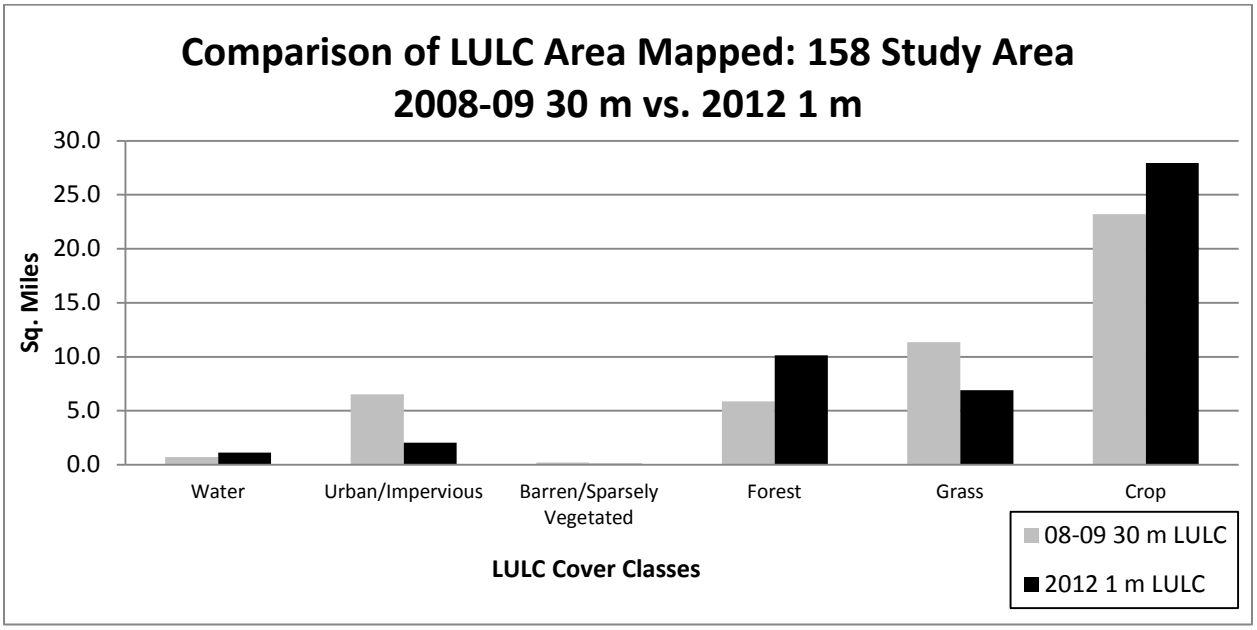

Figure 4.18. Comparison of LULC composition mapped of 2008–09 30-meter LULC and 2012 1-meter LULC in 158 study areas. Fewer significant changes in LULC composition are mapped due to a more homogenous landscaped of mostly crop.

Often large-scale national data sets do not reflect environmental conditions on the ground in urban areas. That was the case with the 2008–2009 LULC, which was based on input data sets (e.g. 30-meter satellite data) that are used in the development of national land cover data sets. These data essentially consider land that has been disturbed as urbanized. Urban planners see diversity of natural elements in urban land cover, despite development, and seek to take advantage of the natural elements present within the urban landscape. The refined data enhance the Ecological Initiative tool and provide urban planners with a mechanism to proactively plan for ecological improvements in the region.

Major efforts are underway in the region to expand greenways and green infrastructure. These efforts are examples of planning efforts that seek to enhance natural elements in the region for broad environmental, social, and economic benefits. The refined data could play a key role in identifying and enhancing key green connections and nodes.

The data communicate to the user the location and extent of impervious cover. This information could play a role in stormwater Phase II planning. Currently state DOTs are working with state environmental agencies on permitting requirements in Municipal Separate Storm Sewer Systems (MS4) communities. The refined data could prove useful in the planning for controlling and managing stormwater runoff.

Although the 2012 1-meter LULC was only completed for two study areas, it is clear that this refined data could have a lager impact if completed for the entire region. From transportation planning, to watershed conservation efforts, there is a sense that the 2012 1-meter LULC would be a valuable resource not only for state DOTs, but for both local and regional government, environmental organizations, and other non-profits engaged in conservation and preservation efforts in the region. Further discussions are needed to determine how this information can be produced, hosted, and served for use within the region.

CHAPTER 5
Beta Test of the C40A Tool: Eco-Plan

Eco-Plan

The C40A team provided the C40B2 team with a beta test of Eco-Plan. The beta test consisted of an exercise for both Eco-Plan and Eco-Plan Advanced; there were a series of steps to follow, and a questionnaire followed the exercises. The C40B2 focus group conducted the beta test. The GIS/Remote Sensing Lead at MoRAP and the Council's focus group members each reviewed the national tool for navigation, interpretation, and data interoperability. Below is a summary of the results of the beta test.

In terms of navigation, the Map Gallery, the associated functionality of the theme maps, and the narrative accompanying the theme maps works very well. These maps are more intuitive than maps under the "Get Started" portion of the site. The fact that the users can be sure they are getting federal data layer feeds straight from the source is an added benefit. .

Regarding interpretation, on the home page, there seem to be a lot of options to choose from, and it may be difficult to determine which option is most relevant to the user's needs. The home page would benefit from enhanced narrative regarding the content of the page, such as a heading or explanation about the three main icons.

The "Learn more" link should not be in that location. Taking a new user to that link so early would lead to a great deal of confusion. Perhaps the ArcGIS Online (AGO) links could be located off to the side, with specific descriptions the content or purpose of the link. Since the intent is to engage low-level GIS users, it is critical to make the main page as easy to move through as possible. Simplicity of use is helpful to the novice or non-GIS user.

The testers saw the need to clarify and streamline the "Get Started" page. Perhaps "Get Started" needs a longer explanation or a rephrased title. It seems to refer to getting started with the IEF, when a user might assume it means to get started with the web tool. The Eco-Plan explanation at the bottom should be at the top of the page as part of the introduction to the site. Moving all AGO-related links and text to one location would be an alternative; perhaps the bottom of page would be good.

Interoperability of the data on site was very good; in particular, the theme maps were interoperable. However, testers noted that some of the data were not up to date. That could be a result of either simply an old data set or state agencies not reporting updates in a timely manner, but the data are the best available on a national level.

While the Council testers benefited from a workplace with a dedicated GIS staff, other smaller planning organizations would benefit from real-time access to the data. The website could be a resource to Council staff members who do not have ArcGIS installed on their computers. The Council has limited ArcGIS licenses, so not all staff members have access to the software. Staff members who wish to take a cursory look at national-level data sets and protected

areas in the region could use Eco-Plan. Also, the explanatory information and metadata provided are helpful so that users know what they are looking at and the limitations of the data.

Eco-Plan Advanced

A majority of the feedback on Eco-Plan Advanced focuses on data interoperability. Some of the best aspects of Eco-Plan Advanced are the speed of data upload and display, as well as the good selection of basemaps and overlays. The tool accomplishes the intended purpose fairly well. Even though the best available data are being used, it is important for users to understand that many of these data sets are out of date and mapped at a fairly coarse resolution. Nothing can be done about this, but users must be aware of this fact and use the data appropriately.

Given the fact that the data layers are accessed via web services, limited functionality of the data is inherent in that approach. To get the full functionality of the data, one would have to download the data directly to a computer, but the issues regarding file size constraints and real-time access to data updates quickly become an issue, which leads back to the initial need for the national data tool. A task that can be completed in Eco-Plan Advanced—but that cannot be carried out in Eco-Plan—is highlighting areas of concern. However, adding map notes, marking up the maps, and changing the color of markups is possible, but this would be disjointed and not likely to be commonly used.

Additional functions recommended for Eco-Plan Advanced include access to more basemap layers, a more robust, customizable user experience, and the ability to save your project with the data you want. Another desirable function of Eco-Plan Advanced is the ability for an entity to upload data through ArcGIS Online (AGO) and establish a community of participants who could access the data through their own AGO accounts. Users could create maps that display critical areas and local ecological data in the region and make those accessible to fellow AGO users at regulatory and resource agencies. However, the limitations associated with AGO costs and crediting system hinder this option. At this time, the Council is not planning to acquire a paid AGO account and take on the cost associated with storing data and covering costs for related downloads and report generation. The Council currently uses the free version offered by Esri to contractual ArcGIS users.

Eco-Plan is a more premade approach for the novice users, and Eco-Plan Advanced is a tool suited to someone more comfortable with GIS and who wants to tailor a project to his or her specific needs. Smaller MPOs that do not have the technical capacity and do not have money to spend on ArcGIS would use the tool if it was at no cost. County-level staffs in transportation and planning departments are potential users as well.

Lastly, an ideal scenario from the Council's perspective would be the ability to upload and store the Ecological Initiative tool on Eco-Plan, thereby making the regional tool publicly accessible. Additionally, a clip-and-ship option for users would be beneficial as well. This technique would allow users to select an area, presumably a project study area, and have a shapefile generated of just the study area containing the pertinent data from the data layer

displayed. That file could then be downloaded to a user's computer at a fraction of the file size of the data layer being accessed.

Eco-Plan Advanced Pilot Area Test

The Eco-Plan Advanced website was demonstrated during the C40B2 February 2014 steering committee meeting. As a part of the demonstration, staff logged onto the agency's existing ArcGIS AGO account and went to My Content to show a list of Eco-Plan maps zoomed in to the extent of our region and previously saved to the agency's account. The map icon in the header bar brought a default view of the continental United States and the "Find address or place" search to navigate to Saint Louis, Missouri was used. Making the map default to a location based on a detected IP address would be an improvement.

Data layers were then added by querying "Eco-Plan" in the Add > Search for Layers dialog box to access data available through Eco-Plan Advanced. The USGS Protected Areas data layer was added. Staff members then uploaded a zipped shapefile of long-range transportation plan projects from a local server. The upload was successful. Within ArcGIS AGO, symbols were modified and various basemaps were tried out. The default imagery basemaps were not as good as our own imagery, so the Council's regional 2012 orthophoto image web service was added to the map for reference (Add > Search for layers > Gateway > EWGateway2012_6inch). The Council's ecological significance data was added. Testers zoomed in to an area where a proposed transportation project appeared to intersect a high-significance area and used the Measure tool to identify the coordinates for potential field review. This feature is nice if a user wishes to conduct a visual inspection of actual field conditions.

Another test was conducted using the pilot areas boundaries. Since ArcGIS AGO could not be accessed from within the Eco-Plan Advanced site, testers logged in from the ArcGIS AGO site, went to My Map > Add > Search for Layer, and searched for Eco-Plan. USFWS Critical Habitat was selected from the list of layers returned by the query. Minimal information was displayed for the Saint Louis region in that layer. Next, the USGS Protected Areas data layer was selected from the query results. That layer showed more features in our region, though it was noted that some recently acquired/protected lands were not present. Data from pilot areas were uploaded using the Add Layer command from the File dialog box. Again, the upload was successful. The screencap below in Figure 5.1 shows the pilot areas in transparent blue overlaid on the USGS Protected Areas Database in the default symbols for the layer.

Other various Eco-Plan layers were explored in relation to the pilot areas. U.S. Environmental Protection Agency (U.S. EPA) EnviroAtlas data was added but did not display even after attempts were made to see the data at various scales and extents. USFWS Riparian Data were added, but the data did not display. Notifications like "No features in your extent" or "Service is temporarily unavailable" would be helpful in these situations. After going to "Item Details" it was discovered that the Riparian Data is a subset of the National Wetlands Inventory (NWI) data that includes Riparian types, and an option to "Open Map" was provided. Despite clicking on

that option, AGO would not allow a new map to be opened without closing and losing data in the existing map, as apparently only one map can be open at a time. Finally, the USGS National Land Cover Database (NLCD) data were added. These data were one of the data sources used by MoRAP to develop the ecological significance data. As shown below in Figure 5.2, this data display provides a reminder of the great improvement the Council has made in the refinement of our region's land cover data over the course of the Initiative. The NLCD raster data seem crude and simplistic when viewed by planners accustomed to our more detailed land cover data set available through the Ecological Initiative tool.

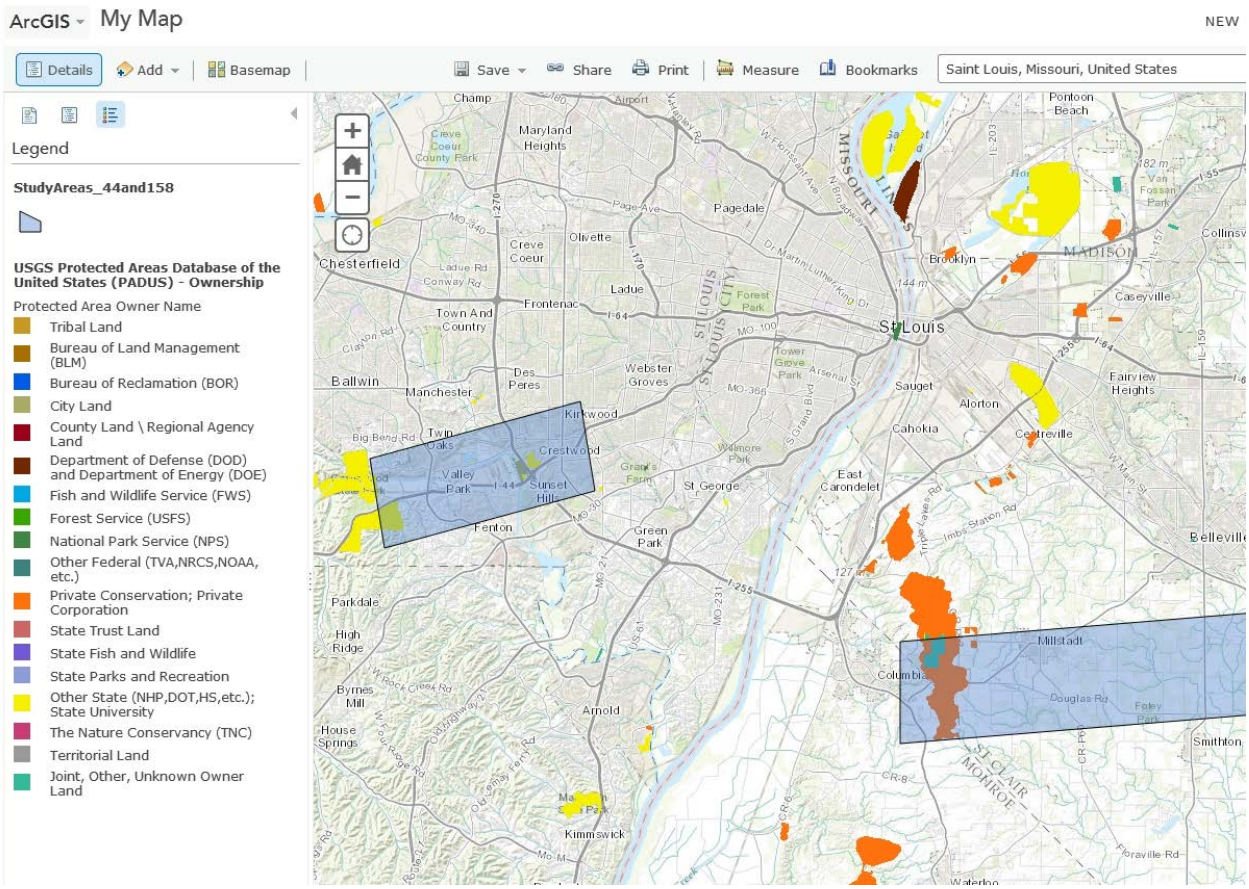

Figure 5.1. Pilot areas displayed over USGS Protected Areas Database.

Transferability of Eco-Plan

The tool seems to fulfill the goals of the C40A project. However, as an agency with a strong investment in desktop GIS, it is unlikely that the Council will use it the tool to conduct an analysis of long-range planning activities. There are several skilled GIS users on staff who know how to access national-level data, if they are needed for analysis. The Council's ability to edit and analyze locally stored data outweighs the convenience of a web-based mapping system. There is some utility in the sharing of interactive maps with partners, but nothing that extends

beyond the capacity the Council already has through other tools. Eco-Plan may be useful for planning agencies without robust GIS resources or very large organizations where GIS skills are cloistered in one department.

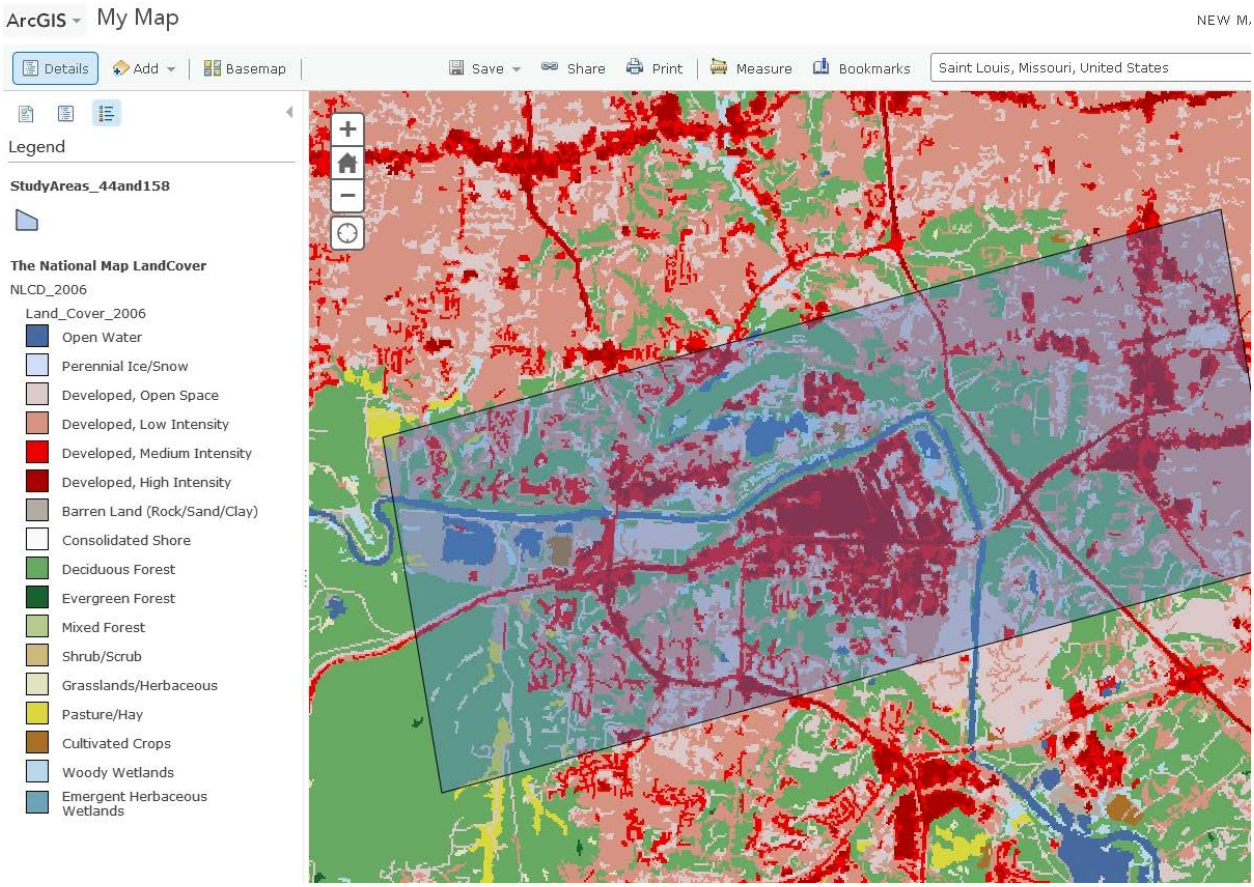

Figure 5.2. I-44 Pilot area displayed over NLCD_2006.

While the functionality of Eco-Plan made a good impression on steering committee members, very few were ArcGIS AGO users, and they would not be in a position to use the Eco-Plan Advanced component of the tool. The benefit is for local government users who may not have access to national-level data sets. The overarching concern of the steering committee is the accessibility of the tool, how users will access it, and what entity will host the site. Regarding functionality, there are two ways Eco-Plan Advanced could be enhanced for better integration in regional and transportation planning: one, if greater freedom to extract data from national data sets was available; and two, if the tool could host the Ecological Initiative tool, thereby improving accessibility of the local geospatial tools.

CHAPTER 6
Transferability of the Ecological Initiative Process and Tool

Based on the work of the Ecological Initiative and work carried out under C40B2, the C40B2 team found that nationally available information on natural resources is often either too coarse or too old to be useful for local planning within major metropolitan regions. Development of reliable, fine-resolution information about a region's ecological infrastructure will help facilitate both conservation of important resources and facilitate efficient project delivery of transportation projects. Use of the same key data sources by resource agencies, such as the Ecological Initiative tool, is critical in order to take a coordinated approach to resource conservation and mitigation efforts.

The Ecological Initiative developed a widely accepted ecological significance geospatial tool for the region through a careful process that included human elements (e.g., involvement of key staff members of appropriate partners) and scientific elements (e.g., use of modern, defensible methods for ecological significance information development). Based on the experience of the C40B2 team, an ecological geospatial tool, once developed, only becomes available and adopted for use by regulatory and resource agencies after a great deal of concerted communication and partnership efforts over the course of several years.

As other regions in the country pursue the development of fine-resolution ecological infrastructure geospatial tools, methods may vary from region to region, but key elements of the overall process include:

- Agreement on a planning region and development of information within that region. In many cases this will include a metropolitan planning region. Note that this does not preclude the use of data from national, state, or regional sources.
- Involvement of stakeholders who have developed information on natural resources or who have interests in transportation planning within the region at all steps. This should include federal, state, and local agencies who are regulated (e.g., DOTs); regulators (e.g., EPA and state equivalents; state fisheries and wildlife agencies); and data providers (sometimes regulated or regulatory agencies, but not always).
- Development of new information that is more relevant to the planning region than what can be acquired from other sources. These data will normally be at finer resolution, both spatially and thematically, than available national data sets, and should be evaluated in terms of significance relative to partner needs within the planning region.

Following the outline of this process will generally lead to iterative improvements in geospatial tools for planning and to iterative adoption of new information for planning within a region. Under the Ecological Initiative: first, a new current vegetation data was developed;

second, large-scale regional ecological significance scoring; third, smaller-scale project-level significance scoring; and, lastly, improvements in wetlands mapping and scoring. As part of C40B2, a fine-resolution mapping of green space and impervious surfaces within urban areas was developed for two pilot areas.

A key concept illustrated by Ecological Initiative efforts is that this process should occur on a planning-region-by-planning-region basis, not necessarily through the development of uniform national data. National efforts might set standards or facilitate planning, but actions tailored to suit local needs may yield best results.

Key elements of natural resource data needs in most planning regions include:

- better rare species mapping and modeling,
- better wetlands mapping and importance scoring, and
- explicit consideration of large-resolution elements of natural diversity (e.g., functional communities and landscapes).

The critical steps to take to develop locally specific geospatial data that contributes to early avoidance of key ecologically significant areas and prioritization of mitigation sites is to compile a basic list of informational needs for all planning regions in the country and then recommend points of contact within federal and state agencies that can assist in the dissemination of data and other resources. Dissemination of case studies would assist planning regions new to the work to identify experts in the field with experience developing such data.

Parallels of Ecological Initiative Tool and Eco-Plan

The insights into transferability of the Ecological Initiative tool mirror the issues that will face Eco-Plan. The intent of the tools is to enhance conservation while improving project delivery. The Ecological Initiative tool is a regionally based geospatial tool and Eco-Plan is a national-level geospatial tool. Both tools need to be in the hands of planners very early in the transportation planning process. In order for that to happen, Eco-Plan needs to be readily available and accessible to users. Both tools need a host agency that can provide access free of charge.

Agencies with small staffs can benefit from the existence of ecological geospatial tools, but limited resources and capacity in GIS skill sets may result in limited use of the Ecological Initiative tool and Eco-Plan Advanced. Eco-Plan will be the best option for small planning departments, because it enhances access to national-level data sets without requiring ArcGIS software. However, these data sets are typically at a very coarse scale. For instance, the USGS National Land Cover Database (NLCD) is so coarse that the data are of limited use for local and regional planning in urban areas. The Ecological Initiative tool can fulfill the desire for fine-resolution ecological data within the Saint Louis region and act as a template for other regions to

develop similar ecological geospatial tools. The two tools complement each other and advance the availability of environmental data for use in transportation planning at the pre-NEPA level.

CHAPTER 7
Conclusions

A great deal of interest in readily accessible geospatial tools for ecological planning exists in the transportation planning community. Regional, statewide, and national data that can be used early in the planning process to assess possible impacts and guide mitigation are of most benefit. At the same time, data that are of fine resolution and that better depict actual on-the-ground (or human-scale) conditions are beneficial for actual mitigation and restoration projects, especially within an urban matrix.

Environmental review conducted by federal and state agencies relies primarily on national-level data sets and, in some cases, on the use of locally developed tools, such EcoCat in Illinois. Federal and state agencies experience the limitations of national data sets and welcome a geospatial tool that provides locally determined ecological priorities and natural resource protection needs. Such locally produced geospatial tools aid in pre-NEPA analysis and contribute to high-level planning within the agencies.

The Ecological Initiative tool development process can be applied to other geographic areas in the country. By following the steps of the IEF, regions can develop locally specific ecological geospatial tools to streamline transportation planning and enhance resource conservation. By following scientifically sound GIS data applications and the latest available remotely sensed data, every region can produce an ecological geospatial tool and obtain the acceptance of regulatory and resource agencies with jurisdiction in the area.

The C40B2 accomplished three primary things. One, the data method of using remotely sensed data to develop the Ecological Initiative tool for a specific geographic area proved to be acceptable by regulatory and resource agencies. Two, Eco-Plan, developed by the C40A research team, was tested and determined to be a useful tool to access national-level environmental data sets for pre-NEPA planning level purposes. And three, the test of the refined land use/land cover classification determined that the refined data can be used by regulatory and resource agencies for transportation planning, watershed conservation, and other green infrastructure efforts. Members of the C40B2 team will continue to work on a file delivery option that makes the Ecological Initiative tool readily accessible for users.