LANDSCAPE-SCALE PLANNING FOR CONSERVATION BUFFERS IN THE CORN BELT*

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ABSTRACT

Extensive land conversion in the Midwest to agricultural production has created an undesirable decline of water quality, wildlife, and other environmental conditions. Conservation buffers can help reverse this trend by reestablishing perennial vegetation, which functions to produce and sustain these ecological values. In the Corn Belt, it is imperative to plan each acre of buffer in order to restore an acceptable level of ecological health to agricultural landscapes without jeopardizing farm production. At the National Agroforestry Center, we are developing a planning framework that will demonstrate how geospatial information can be used in GIS-based system for conservation buffer planning. This framework involves three primary components; regional reconnaissance, landscape scale buffer plan, and site scale buffer plans. This simple but effective framework should be a useful tool for agency personnel, non-governmental organizations, and private citizens to achieve multiple objectives with conservation buffers.

1.0 INTRODUCTION

Intensive agricultural production in the Corn Belt ecoregion has created an undesirable decline of water quality, wildlife, and other environmental conditions. Conservation buffers can help reverse this trend by reestablishing strips of perennial vegetation, which can improve the ecological functioning of the agricultural landscape. Conservation buffers can also provide societal benefits such as recreational opportunities and aesthetic enhancement. To optimize multiple benefits, buffers must be planned and designed using information gathered from a variety of spatial and temporal scales. However, a comprehensive methodology illustrating how geospatial data can be combined and used for conservation buffer planning does not currently exist.

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1.1 PLANNING FRAMEWORK

The National Agroforestry Center is developing a conservation buffer planning framework that will integrate information from a variety of spatial and temporal scales. The framework will demonstrate how to locate, combine and synthesize this information, including measured data, remotely sensed data, stakeholder input, and computer modeling results in a GIS-based system. There are three primary components of the planning framework; regional reconnaissance, landscape scale buffer plan, and site scale buffer plans (Figure 1).

The framework begins with a regional reconnaissance to provide context for the conservation buffer planning process. One purpose of the reconnaissance is to provide a regional assessment of environmental conditions and resource issues regardless of what initial issues or problems brought stakeholders together. Often, buffer planning efforts are focused on single problems. However, by looking at the regional context, stakeholders are encouraged to consider multiple resource issues in their buffer planning effort and to capitalize on capabilities of buffers to address several issues simultaneously.

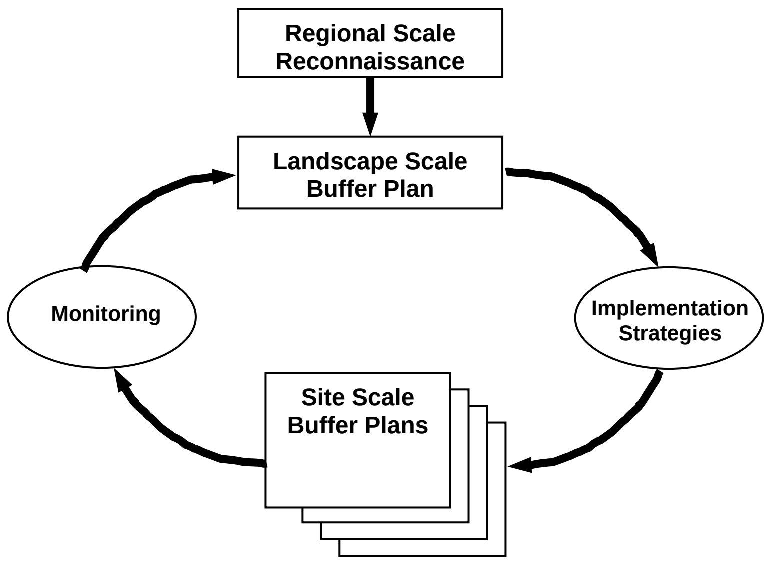

Figure 1. Conservation Buffer Planning Framework

At the landscape scale, the primary tasks are to identify desired future conditions; buffer functions that create those desired future conditions, and optimum buffer locations and design criteria for doing so. Implementation strategies for the landscape buffer plan include gathering support and funding for projects, policy changes, and targeting resources for priority areas. The site scale component of the framework incorporates information generated in the landscape plan into objectives and design options for sites. Design options include buffer size, composition, and management. Both landscape and site scale monitoring provide valuable information that is fed back into the planning process to evaluate impacts of current plans and indicate need for adjusting plans to achieve stated goals.

1.1.1 Question-driven Approach

A detailed diagram of the conservation planning framework is provided in Figure 2. Each step in the framework is characterized by a core question that guides the step. The framework and core questions are purposely kept generic to facilitate the consideration of many and various issues. The buffer-specific element of the framework is developed through a tiered set of questions underneath each core question (Figure 3). These questions will assist the team in planning and designing holistic buffer systems that simultaneously address several issues.

In the documentation for using this planning framework, specific techniques for answering the questions will be provided. The techniques will present step-by-step guidance for combining geospatial information in a GIS-based system. Current research will be used to tailor the techniques for the Corn Belt ecoregion. Both the questions and techniques will be based upon ecological functions and how conservation buffers can modify those functions. The planning team will have the option to use the suggested techniques or to develop their own methods for answering the questions.

A question-driven approach has been used in several planning frameworks because questions provide specific but flexible guidance for analyzing resources and developing plans (Montgomery et al. 1995, Smith and Hellmund 1993, and Steinitz 1990). This approach is particularly valuable to prevent issues from inadvertently being overlooked. It also allows a framework to be tailored for a specific purpose, in this case, conservation buffers. Additional questions and techniques for non-buffer issues can be developed and added to this framework as necessary.

2.0 THEORETICAL EXAMPLE

A theoretical example is used to illustrate the use of our planning framework. This example is used only to give a conceptual overview of the process and does not provide explicit detail for each of the planning steps. Our example begins in the Dove Creek, Iowa watershed, where stakeholders have initiated a buffer planning effort because nitrogen was exceeding drinking water standards in many of the streams in this predominantly agricultural watershed.

2.1 REGIONAL RECONNAISSANCE

To provide context for the watershed, the Dove Creek stakeholders conducted a regional reconnaissance using existing data (Table 1). Although this type of data is coarse, it quickly informed stakeholders about other important resource issues in the region. This quick reconnaissance showed that wildlife biodiversity is significantly declining and that exotic weeds are rapidly increasing in the area. Aerial photos from several decades and oral historical accounts also indicated that the visual quality of the region has deteriorated due to conversion of riparian floodplains to cropland.

This reconnaissance effort motivated the Dove Creek stakeholders to broaden their planning scope. The group decided to include wildlife and aesthetic concerns in their buffer planning effort, but chose to ignore addressing the exotic weeds issue for various reasons. In addition, the stakeholders started to sense some connection between resources such as the possible linkage between the elimination of riparian vegetation, and declining water quality and wildlife populations.

Inventory Questions

Core Question
How should the landscape be described?

1.0 How should the hydrological system be described in the study area?
- 1.1 What are the main hydrological pathways?
- 1.2 How is the hydrological system altered by past and present human use?
- 1.3 Where are existing buffers modifying the hydrological system?

2.0 How should biodiversity be described in the study area?
- 2.1 What are critical areas for biodiversity?
- 2.2 How is biodiversity altered by past and present human use?
- 2.3 Where are existing buffers modifying biodiversity?

Analysis Questions

Core Question
Is the landscape functioning well?

1.0 How is the hydrological system functioning in the study area?
- 1.1 What and where are potential sources of water quality problems?
- 1.2 What processes are triggering water quality problems?
- 1.3 How are existing buffers functioning in relation to the hydrological system?

2.0 How is biodiversity functioning in the study area?
- 2.1 Where and what are biodiversity problems and opportunities?
- 2.1 What processes are limiting biological diversity?
- 2.3 How are existing buffers functioning in relation to biodiversity?

Plan Development Questions

Core Question
How should the landscape be altered?

1.0 How should the hydrological system be altered to achieve desired future conditions?
- 1.1 Which buffer functions are necessary to alter the hydrological system?
- 1.2 What are the key characteristics of these types of buffers?
- 1.3 Where should these buffers be located?
- 1.4 Where are buffers ineffective in achieving cleaner water?

2.0 How should the landscape be altered to maintain and improve biodiversity?
- 2.1 Which buffer functions are necessary to improve biodiversity?
- 2.2 What are the key characteristics of these types of buffers?
- 2.3 Where should these buffers be located?
- 2.4 Where are buffers ineffective for improving biodiversity?

Plan Evaluation Questions

Core Question
What predictable changes might the landscape scenarios cause?

1.0 How will the landscape scenarios impact the hydrological system?
- 1.1 How will the scenarios affect water quality?
- 1.2 How will the scenarios affect water quantity?

2.0 How will the landscape scenarios impact biodiversity?
- 2.1 How will the scenarios affect species richness?
- 2.2 How will the scenarios affect species viability?

Figure 3. Example of Landscape Scale Planning Questions

Note*: This illustration provides a simplified example of the question-driven approach. Questions for other resources are being developed including questions for site scale buffer plans.*

Table 1. Dove Creek Regional Reconnaissance (*List is not complete*)

Regional Data Source	General Information Available
NRCS – Natural Resource Inventory	Water and wind erosion Threatened and endangered species Other information
EPA Index of Watershed Indicators	Water quality problems and vulnerability Aquatic /wetland species at risk Other information
State GAP Analysis	Wildlife species richness
Aerial Photos	Spatial landscape change over time
NRCS – Social Science Institute Data Access • Compilation of data from the U.S. General Population Census and U.S. Agricultural Census	Demographics Population and economic trends

2.2 LANDSCAPE SCALE BUFFER PLAN

2.2.1 Landscape Inventory and Analysis

Following the question-driven framework, the stakeholders gathered geospatial information from a variety of sources to analyze their key issues. Table 2 illustrates some of the data the Dove Creek group decided to use. A comprehensive, function-based assessment was completed by using the suggested techniques to answer the inventory and analysis questions.

The analysis revealed that in the upper watershed, nitrogen transport was occurring during late spring storms, which produced overland flow. The lack of riparian vegetation in certain areas within the watershed was allowing untreated runoff to enter streams. In the lower portion of the watershed where several municipalities received their water supplies, the analysis revealed that nitrogen was entering streams through subsurface flow.

The analysis demonstrated that general wildlife biodiversity and populations were being hindered by the lack of riparian habitat. In upland areas, wildlife mortality during winter was high due to the lack of adequate cover and food. In regards to aesthetic concerns, a simple survey of stakeholders indicated dissatisfaction with eroding stream banks in the lower portion of the watershed near municipalities. In addition, the upland areas were denoted as monotonous because of extensive row crops.

The analysis provided the necessary information for the group to realistically describe their desired future conditions and goals for the Dove Creek watershed. Specific objectives based upon the data from the analysis were developed for future monitoring efforts.

Table 2. Dove Creek Landscape Scale Data Sources (*List is not complete*)

Water Quality Data	Wildlife Biodiversity Data	Aesthetic Data
Output from a process based watershed model such as AGNPS	Single species habitat models	Survey of residents aesthetic preferences
Aquifer recharge zones	Diversity “hotspots”	Aerial photos
Field-collected macroinvertebrate sampling results	At risk habitat patches	Other historical photos
Municipal water supply locations	Population trend data	
Meteorological data	Species occurrence/range maps	

2.2.2 Landscape Plan Development

During the landscape buffer plan development, the Dove Creek group reviewed their desired future conditions and the landscape analysis results. The group identified the ecological functions and characteristics of buffers needed to solve these problems and capitalize on opportunities. Considering these functions, general locations of buffers were delineated on the landscape plan.

In the upper portion of the watershed, riparian buffers were suggested to filter surface runoff, provide a corridor for wildlife movement as well as provide habitat. Field buffers in upland areas were incorporated in the plan to address water quality, aesthetic, and biodiversity issues. Field buffers serving as a sink would reduce potential nitrogen overloading of the riparian buffers. These buffers would also serve as a barrier breaking up the visual monotony of the row cropped landscape. In addition, field buffers consisting of shrubs and grasses would provide critical winter food and cover for wildlife.

The planning process also informed the group where buffers would be ineffective. In the lower watershed, the team determined that nitrogen transport in the subsurface flow was occurring below the potential rooting depth of buffer plantings. Consequently, a buffer would not be an effective tool for filtering this source of nitrogen. The Dove Creek group decided, however, to still use buffers in this area to connect gaps in riparian habitat and to stabilize eroding stream banks.

General design criteria were developed to provide additional guidance for future site scale planning and design efforts. One criteria suggested that cool-season grasses instead of warm-season grasses should be used when filtering runoff. This criteria was established after the analysis revealed that runoff was produced primarily in late spring, which would be best filtered by actively growing cool-season grasses.

2.2.3 Landscape Plan Evaluation

The stakeholders generated several plan scenarios with various intensities of buffer placement in the watershed. The group evaluated and compared the scenarios using water quality, biodiversity, and visual assessment tools. In addition, the group also evaluated the scenarios using other assessment tools such as economics and water quantity (i.e. flooding). This comprehensive evaluation allowed the Dove Creek group to better understand the range of potential impacts of the different scenarios. Using a consensus-based approach, a preferred scenario was selected by the group.

2.2.4 Implementation Strategies

Several federal, state, and non-governmental agencies were willing to fund buffer projects because the Dove Creek group managed to create a publicly-supported comprehensive landscape buffer plan. With the landscape buffer plan, conservation planners were now able to focus their efforts on key areas within the watershed.

The landscape planning process also revealed that buffers would not be an effective conservation practice in the lower portion of the watershed for addressing nitrogen pollution. However, because these areas are critical for municipal water supplies, the Dove Creek group decided to pursue a policy solution. The group was able to encourage local legislators to fund a program that encouraged proper nutrient management in the watershed.

2.3 SITE SCALE BUFFER PLANS

After a visit by the local conservation planner, the Jones in the Dove Creek watershed decided to develop a buffer plan for their farmstead. Since the Jones had participated in the Dove Creek planning process, they supported the same issues. They were also interested in buffers that would provide alternative income and would not take too much land out of crop production. Using the landscape plan as a guide, the conservation planner inventoried and analyzed the Jones' property at a finer resolution. Together, the planner and the Jones developed site-specific objectives for the property.

With the site scale analysis and specific landowner objectives, the conservation planner and the Jones refined the location of buffers presented in the landscape plan. Physical dimensions and composition of the buffer system were designed using site scale information and design criteria developed during the landscape buffer planning effort.

A riparian buffer design was developed with two primary components: a grass filter strip with native cool season grasses and a mixed hardwood and native riparian community for alternative income and wildlife habitat. Upland field buffers were designed for the farmstead as suggested in the landscape plan. Guidelines for managing the buffer systems were also developed.

2.3.1 Monitoring

As the conservation planner continued to work with other Dove Creek landowners in developing site plans, the landscape plan was methodically being implemented. The baseline data and objectives established during the landscape plan were used to assess the effectiveness of the buffer planning effort. Formal monitoring during the first couple of years showed no significant change. However, as additional site plans were implemented and buffer vegetation matured, monitoring results demonstrated a positive shift toward the group's desired future conditions. Less intensive monitoring of site scale plans was also conducted to ensure that specific landowner objectives were being achieved.

3.0 CONCLUSION

Although this example was conceptual, it demonstrates that a comprehensive framework is essential for efficient and effective use of geospatial information for conservation buffer planning. Through the application of a question-driven, function-based framework, the Corn Belt region can significantly benefit from multiple objective conservation buffers.

4.0 REFERENCES

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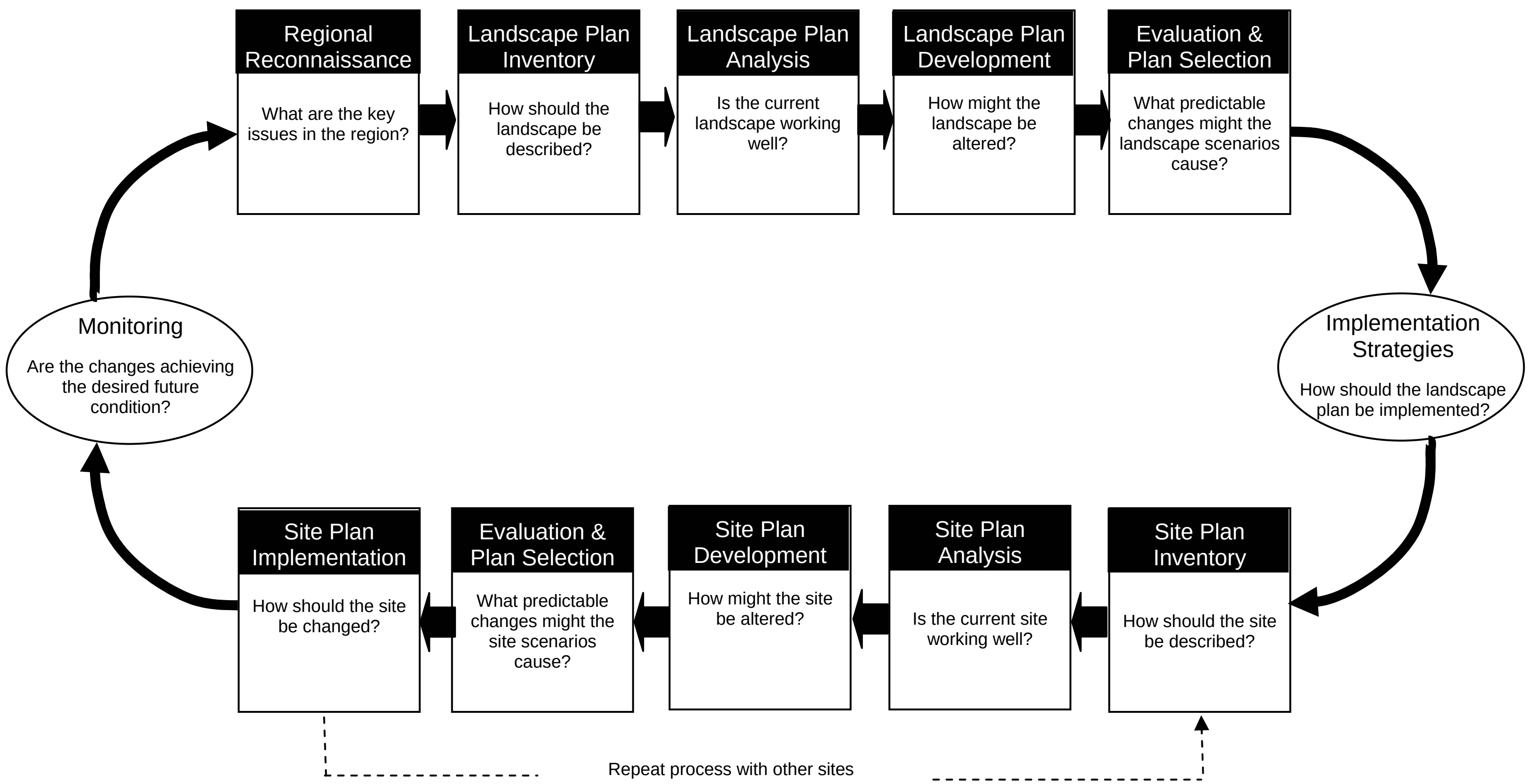

Figure 2. Conservation Planning Framework