Landscape and Urban Planning 134 (2015) 195–209

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Research Paper

# Linking ecology and aesthetics in sustainable agricultural landscapes: Lessons from the Palouse region of Washington, U.S.A.

Linda R. Klein[a,*], William G. Hendrix[b], Virginia I. Lohr[c], Jolie B. Kaytes[b], Rodney D. Sayler[d], Mark E. Swanson[d], William J. Elliot[e], John P. Reganold[f]

[a] School of the Environment – College of Arts and Sciences, Washington State University, Pullman, WA 99164-2812, USA
[b] School of Design and Construction, Washington State University, Pullman, WA 99164-2220, USA
[c] Department of Horticulture, Washington State University, Pullman, WA 99164-6414, USA
[d] School of the Environment – College of Agriculture, Human, and Natural Resource Sciences, Washington State University, Pullman, WA 99164-6410, USA
[e] Rocky Mountain Research Station – Moscow Forestry Sciences Laboratory, USDA Forest Service, Moscow, ID 83843, USA
[f] Department of Crop and Soil Sciences, Washington State University, Pullman, WA 99164-6420, USA

## HIGHLIGHTS

- We measured aesthetic and ecological responses to variations in landscape structure.
- Erosion rates decreased with successive additions of conservation buffer elements.
- People preferred landscape scenes with greater amounts of buffer vegetation.
- GeoWEPP erosion modeling can help prioritize buffer placement at watershed scales.
- Aesthetic and ecological quality can coincide in agricultural landscape structure.

## ARTICLE INFO

*Article history:*
Received 1 February 2014
Received in revised form 20 October 2014
Accepted 23 October 2014
Available online 19 November 2014

*Keywords:*
Agricultural landscape ecology
Conservation buffer system
Ecosystem services
GeoWEPP modeling
Landscape preference
Multifunctional landscapes

## ABSTRACT

Inspired by international escalation in agricultural sustainability debates, we explored the promise of landscape-scale conservation buffers to mitigate environmental damage, improve ecological function, and enhance scenic quality. Although the ecological benefits of buffer vegetation are well established by plot- and field-scale research, buffer adoption by farmers is limited. Landscape-scale approaches can address several obstacles by simultaneously considering ecological impact, economic efficiency, and aesthetic quality and preference in buffer placement and design. Within four watersheds of Washington's Palouse farming region, we examined relationships between ecological and aesthetic responses to the existing landscape structure plus three alternative scenarios, differentiated by successive increases in woody buffers. Methodology combined GIS analysis, digital image simulation, soil erosion modeling and mapping, and a landscape preference survey. Landscape ecological function, measured by erosion and deposition rates, improved as buffer elements were added into each successive scenario. Magnitude of improvements varied among scenarios and among watersheds, revealing opportunities for targeting buffers to maximize ecological benefits and economic efficiency. Concurrently, aesthetic preference, measured as scenic quality ratings, increased significantly ($p < 0.05$) from the existing landscape through the second successive scenario of improved ecological function. No preference difference was found between the second and third scenarios. Results expand current understanding of multifunctional relationships in agricultural landscapes and encourage future research on whether linking ecological and aesthetic quality in buffer design might favorably influence adoption. Results also suggest that, within certain landscape contexts, visually perceivable attributes can provide a relative and coincident indication of ecological function, aesthetic quality, and agricultural sustainability.



* Corresponding author. Present affiliation/address: LRK Consulting ~ Writing, Editing, & Project Coordination, 440 SE Hill Street, Pullman, WA 99163, USA.
Tel.: +1 509 339 3529.
*E-mail addresses:* linda.klein@wsu.edu (L.R. Klein), whendrix@wsu.edu (W.G. Hendrix), lohr@wsu.edu (V.I. Lohr), jolie@wsu.edu (J.B. Kaytes), rdsayler@wsu.edu (R.D. Sayler), markswanson@wsu.edu (M.E. Swanson), welliot@fs.fed.us (W.J. Elliot), reganold@wsu.edu (J.P. Reganold).

http://dx.doi.org/10.1016/j.landurbplan.2014.10.019
0169-2046/

## 1. Introduction

Ongoing environmental degradation, world population projections of nine billion by 2050, and recognition that most productive cropland is already in use have ignited renewed vigor in agricultural sustainability and food security debates (Chappell & LaValle, 2011; Godfray, Pretty, Thomas, Warham, & Beddington, 2011; NRC, 2010; The Royal Society, 2009). Considerable research has contrasted the merits and shortcomings of conventional versus alternative forms of agriculture to ensure future production while protecting biodiversity, natural resources, and ecosystem services (Chappell & LaValle, 2011; Scherr & McNeely, 2008; Tilman, Cassman, Matson, Naylor, & Polasky, 2002; Trewavas, 2001). Reexamination of opposing arguments, including those establishing the "land-sparing" versus "wildlife-friendly" farming dichotomy (Fischer et al., 2008; Green, Cornell, Scharlemann, & Balmford, 2005), reveals noteworthy agreement on several widely applicable, sustainability strategies, regardless of agroecosystem type employed.

Gaining particular consensus is the idea that landscape approaches, which coordinate multiple farms, are necessary to realize significant reductions in off-site environmental damage or improvements in ecosystem services (Maresch, Walbridge, & Kugler, 2008; Tscharntke, Klein, Kruess, Steffan-Dewenter, & Thies, 2005). One such strategy is integrating landscape-scale conservation buffer systems to complement on-farm sustainability practices that improve water infiltration, soil retention, and input efficiency (Bentrup, 2008; Groffman, Capel, Riitters, & Yang, 2007; Lowrance & Crow, 2002; Scherr & McNeely, 2008). In contrast to the small area upon which they are typically planted, permanent vegetation buffers can deliver disproportionately high amounts of ecological function and beneficial ecosystem services (Lovell & Sullivan, 2006). However, because empirical evidence on buffer function and efficacy is predominantly based on field-, plot-, and buffer-specific (windbreaks, field borders, grassed waterways, riparian plantings) studies, our understanding of how benefits translate to larger spatial scales is limited (Lovell & Sullivan, 2006; Smukler et al., 2010).

Understanding conservation buffer function at landscape or watershed scales may also help overcome social, economic, and policy obstacles that, so far, prevent widespread adoption of buffers despite their known ecological benefits. For example, when assessing collective off-site effects for buffer placement and design, not all farms will contribute equally to negative impacts on environmental quality or to positive influences on ecosystem services. This phenomenon, termed disproportionality, reflects variations in conservation behavior of farmers and in spatial location and biophysical setting of farms (Nowak & Pierce, 2007; Walter et al., 2007). By intentionally targeting buffers and encouraging and compensating buffer adoption in settings of high sensitivity and critical ecological function, a landscape approach can maximize societal and landowner benefits while minimizing monetary investments (Groffman et al., 2007; Maresch et al., 2008; Scherr & McNeely, 2008).

Moreover, agricultural landscapes contribute cultural benefits by functioning as everyday nature, open space, scenic beauty, and recreational areas that can sensuously delight and emotionally inspire (Antrop, 2000; Arler, 2000; Brady, 2006; Dubos, 1976; Lowenthal, 2007). Undeniably, humans have long held a multi-faceted and culturally ingrained connection with the countryside—a sentiment captured in the pastoral aesthetic, which conceptualizes agricultural landscapes as perpetually green, peaceful, comforting, and productive (Marx, 1964; Schauman, 2007). Despite negative environmental impacts associated with some agricultural practices, farmers are often collectively characterized as good stewards—implying devoted and enduring human–land relationships that ensure productivity and protect natural resources (Nowak & Pierce, 2007). This stewardship ethic is partially idealized in visions of agricultural landscapes as neat and well-kept patterns of barns, fields, fences, and rows of crops—visual qualities also explained by Nassauer's (1997) aesthetic of care.

Importantly, although people may be unmoved by scientific or moral arguments for resource conservation, they often feel strongly about the care and protection of landscapes that evoke sensuous and emotional gratification (Meyer, 2008; Parsons & Daniel, 2002; Stokes, Watson, & Mastran, 1997). Enhanced aesthetic quality is frequently presumed an ancillary ecosystem service that automatically accrues from incorporating buffers, particularly those comprised of tree and shrub (woody) species, into an otherwise homogeneous agricultural landscape. Several researchers (e.g., Décamps, 2001; Gobster, Nassauer, Daniel, & Fry, 2007; Lovell & Sullivan, 2006; Meyer, 2008) have recognized the potential for aesthetic experiences to serve as catalysts for motivating conservation and sustainable land-use behavior. Indeed, Lovell and Sullivan (2006) identified a limited understanding of the importance of aesthetic preference in buffer design as one of several obstacles to widespread buffer adoption in the US. Other obstacles included a need for watershed-scale research and for interdisciplinary approaches that explore relationships among economic, aesthetic, and ecological goals in highly productive agricultural landscapes (Lovell & Sullivan, 2006).

Landscapes of high aesthetic quality may or may not be compatible with high ecological function (Gobster et al., 2007). To understand how aesthetic experiences might motivate conservation behavior, we must first ask under what conditions, and to what extent, can ecological and aesthetic values coincide in perceptible landscape structure. To answer this question and begin to fill identified knowledge gaps, our study examined ecological and aesthetic responses to agricultural landscape changes induced by successive additions of woody buffers. A paucity of empirical research directly and purposely measures ecological–aesthetic relationships within the biophysical structure of active farmland and from the scale and perspective of everyday human experience.

In Europe, studies have been concerned with public visual preferences relative to cropping intensification on highly productive lands and to nature conservation and reforestation on less productive, abandoned farmland (e.g., Hunziker & Kienast, 1999; Lindemann-Matthies, Briegela, Schüpbachb, & Junge, 2010; Van den Berg & Koole, 2006). Other studies have focused on varying objectives such as landscape scenic value as a farmland preservation strategy (Schauman, 1988; Stokes et al., 1997), buffer design preference for mitigating conflicts at the urban–rural fringe (Sullivan, Anderson, & Lovell, 2004), and visual quality comparison of organic versus conventional agricultural systems (Egoz, Bowring, & Perkins, 2006). To our knowledge, no study has concurrently measured changes in ecological function and aesthetic preference in direct response to integrating woody conservation buffers within modern, intensively managed agricultural landscapes.

In environmental psychology, empirical studies using perception-based assessments generally interpret human preference for a particular landscape as a measure of its aesthetic quality. Preferred landscapes are understood as having high visual aesthetic quality (Daniel, 2001; Kaplan & Kaplan, 1989; Nassauer, 1995). Although cultural context and personal characteristics, knowledge, and experience certainly influence aesthetic judgment, an extensive body of research finds a notable consistency in preference for particular landscape attributes. Some of these preferred attributes exist to varying degrees in agricultural landscapes (Table 1). We hypothesized that several attributes would be enhanced with the integration of woody buffer systems. Furthermore, if the same buffer systems also improved water infiltration, enhanced soil retention, and/or reduced soil erosion, higher ecological and aesthetic quality would coincide in visually perceivable landscape attributes.