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Using the past to plan for the future: Retrospective assessment of landscape and land use change in the Clear Creek Watershed

Abstract: Using aerial photos and historical records allowed researchers to create a compelling picture of the changes in the Clear Creek watershed since 1940.

Question & Answer

Q: Can significant events contributing to the overall health and functioning of agricultural watersheds be understood through the study of landscape history?

A: Analysis of landscape history reveals significant changes in space and time. Examples from this study include the identification of persistent patches of remnant natural vegetation and areas of concentrated urban or suburban development, and pinpointing periods of rapid change in the stream network. Such knowledge can be used to inform future conservation planning and/or regional development policies.

Background

Significant opportunities exist to improve the overall health and functioning of agricultural landscapes such as those found in the Clear Creek watershed of eastern Iowa. To achieve the greatest efficacy, these opportunities should be evaluated at landscape scales and be attuned to where these landscapes have been in the past, as the history of a landscape has enduring effects on its present and future condition.

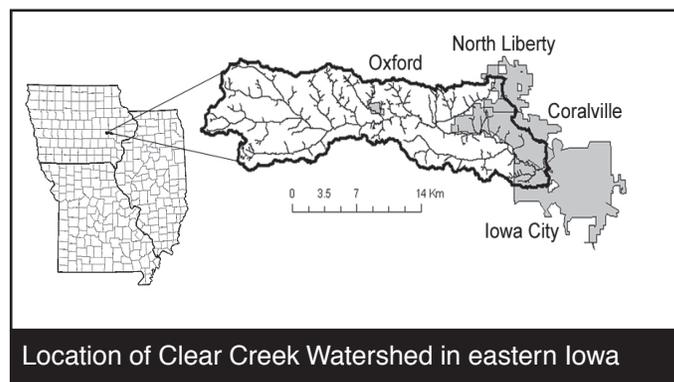
In studying landscape history and change, the project investigators had these goals:

- Establish a quantitative baseline for assessing present and future landscape change,

- Delineate periods of rapid change, when landscape conditions are dramatically altered, and the causes of this change, and
- Provide a richer story of the interactions between humans and their environment for the purposes of furthering conservation initiatives.

Approach and methods

The project work was conducted in the Clear Creek watershed, which covers nearly 68,000 acres in east central Iowa. Over the past 150 years, the majority of land in the watershed has been converted from its natural state to row crops or pasture. The hydrology of the watershed also has been greatly altered through construction of drainage systems and widespread channelization of streams and other waterways. More recently, the area has been experiencing significant urban growth. These and other factors make the region ideal for a study of the causes and consequences of landscape change.

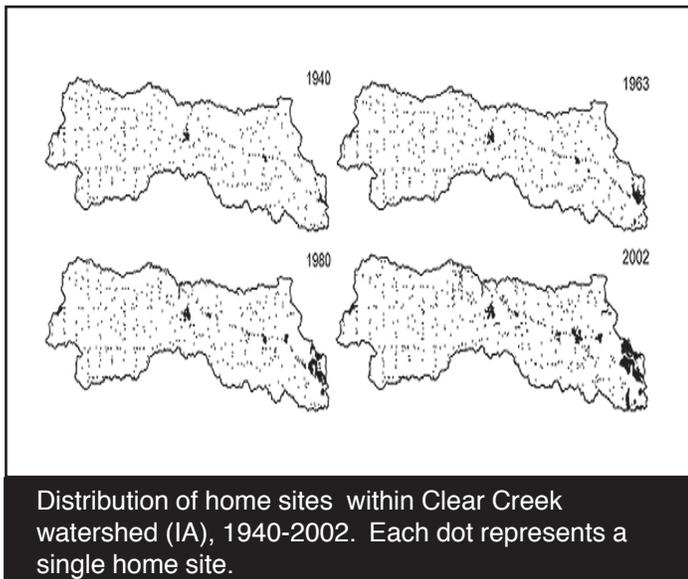


Principal Investigator:
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Co-investigator:
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Budget:
\$12,998 for year one
\$2,000 for year two

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The primary data source for the analysis was historical aerial photography. The researcher team scanned, geo-referenced, and digitized landscape features from the aerial photos of Clear Creek watershed at four times; on or about 1940, 1960, 1980, and 2002. (The earliest dated aerial photos of the watershed were from 1938.)

Other historic data were incorporated to enhance the story of landscape change (in particular, the persistence of patches of remnant natural areas), including maps from historical state atlases and the original public land surveys conducted in the mid-1800s.

Results and discussion

Analyses conducted by the team quantified important ecological and social processes that occurred in the watershed, including:

- A continuous decline in agricultural cover, coupled with concomitant increases in urban and forest cover,
- A decrease in stream sinuosity over time as stream flow patterns have been altered, and
- An increase in housing density near urban areas and along road corridors, but declines elsewhere in the Clear Creek watershed.

While nearly the entire native habitat found in the watershed has been converted to agriculture or developed for housing and commercial uses, the project team also found locations that apparently have remained in a more natural

condition since 1840 when the area was first settled by Euro-Americans. Depending on the ecological characteristics (such as the degree of degradation) of these remnant natural patches, they may play important watershed conservation roles in terms of habitat provision, water quality, and recreation.

By 1940, the landscape outside of these remnant patches already had been modified extensively. Since then, crop cover has declined, while forest and urban cover have increased. The present day watershed continues to be dominated by agricultural land use, yet the observed increases in both urban and forest cover (particularly since 1980) suggest that these cover types may become more common within the watershed in the future.

Stream sinuosity, one component of the broader suite of hydrological modifications to the watershed since settlement began, declined dramatically between 1940 and 1963. This decline may have had enduring effects on water quality and riparian habitat within Clear Creek.

Housing density has increased dramatically from 1940 to 2002, with an especially rapid rate of increase seen in the last two decades. Urbanization of formerly rural landscapes has been observed throughout the Midwest, and this trend has been linked to ecological and social changes with potential to further alter Midwestern agricultural landscapes.

Conclusions

Declines in main channel stream sinuosity observed from 1940 to 1963 have persisted in the present-day landscape, although project results hint that sinuosity may be increasing slightly in recent decades. Urbanization most likely will continue to be an important driving force of landscape change, particularly increases in rural housing density that have the potential to further fragment and transform rural regions within the watershed.

The results of the research demonstrate that considerable landscape change occurred within the Clear Creek watershed between 1940 and 2002. The results are consistent with other studies of changes in Midwestern landscapes during the 20th century and provide an example of a Midwestern agricultural landscape that is dynamic both in space and time.

These findings may be used in conjunction with other data to parameterize hydrological models or in the development of alternative future land use scenarios for Midwestern landscapes. Depending on the availability of historic data, the methods presented here may be employed in other Midwestern regions in order to investigate changes in forested landscapes since settlement by Euro-Americans and to identify remnant forest patches. The need for such work is increased by the degree to which many Midwestern landscapes have been transformed, and by the paucity of native habitat that remains in such regions.

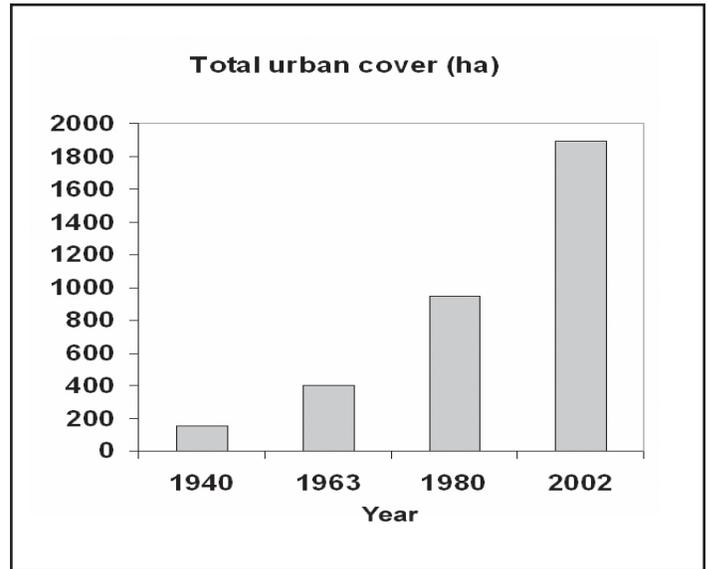
Impact of results

Results from this project form the basis for restoration planning by a local watershed coalition group, illustrating the potential for similar research to inform conservation planning in managed landscapes. Such efforts are timely, given the current shift between agriculture and urban lands in regions of the Midwestern United States. These shifts represent opportunities, but require a landscape perspective to be most effective and a historical baseline to document improvements, both of which were generated by this project.

Education and outreach

Publications stemming from the project included a master's thesis, and manuscripts submitted to two scholarly journals, *Natural Areas Journal* and *Landscape Ecology*. A fact sheet (Clear Creek Watershed: 150 Years of Landscape Change) was produced and can be accessed at www.leopold.iastate.edu/pub/landscapes/clear_creek/. An online gallery of landscape change for Clear Creek Watershed is available at www.nrem.iastate.edu/landscape/projects/ccw/gallery/ccw_interactive.

Presentations about the project were given at the 21st Annual Symposium of the U.S. Regional Association of the International Association of Landscape Ecology, the



Nature Areas Conference, the 5th Annual Water Monitoring Conference, the Clear Creek Watershed Enhancement Project, the ISU Global GIS Day symposium, and to the ISU Agricultural Systems Performance and Management Initiative team.

Leveraged funds

This research assisted in leveraging support from the USDA Forest Service North Central Research Station. Through this grant, L. Schulte and the collaborators are working to develop an integrative watershed assessment model for use in educational and participatory research settings.

The Clear Creek Watershed Enhancement Project further used this research to help secure a U.S. Environmental Protection Agency (EPA) Section 319 grant from the EPA Nonpoint Source Management Program and an Iowa Watershed Development and Planning Assistance grant for watershed improvements to enhance pollution control.

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