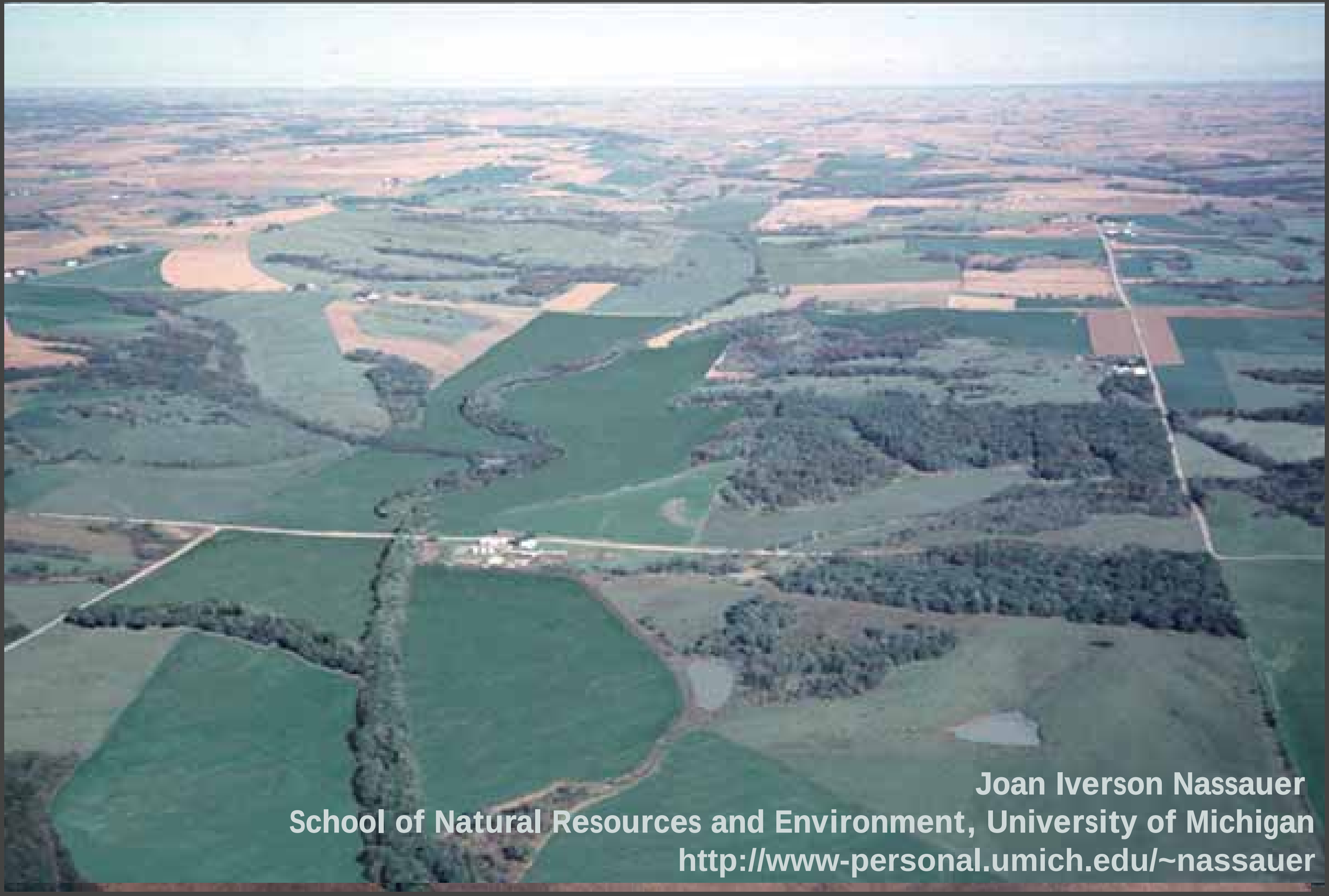
Using Future Landscape Scenarios to communicate among disciplines and stakeholders

"A landscape design perspective could improve the ability to understand and manage the complex system that is affecting hypoxia of the Gulf of Mexico." EPA SAB Hypoxia Advisory Panel. 2008.

"There is a need for… alternative scenarios for generating landscape patterns and integrated assessments of alternative futures." Toward Sustainable Agricultural Systems . NRC 2010.



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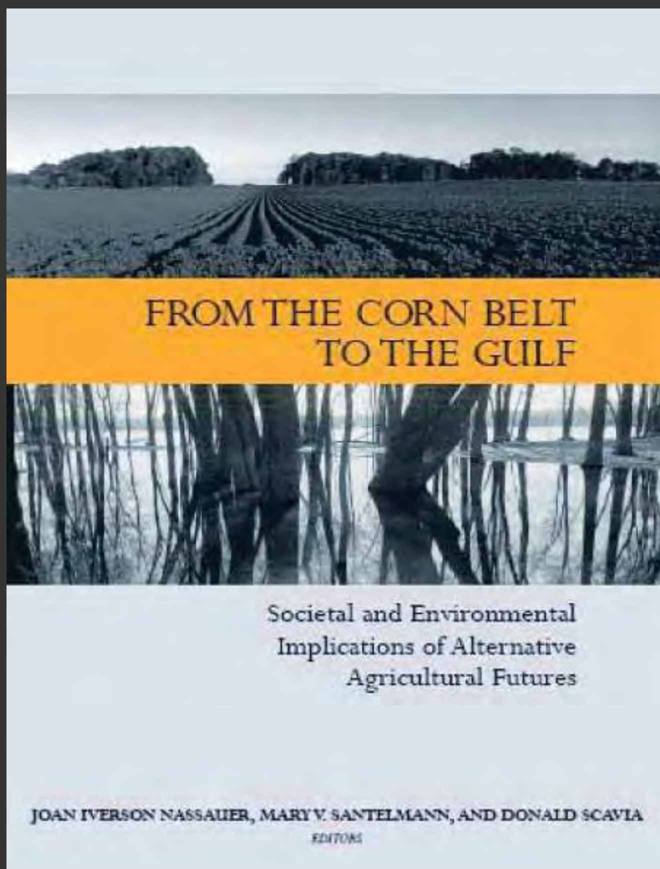
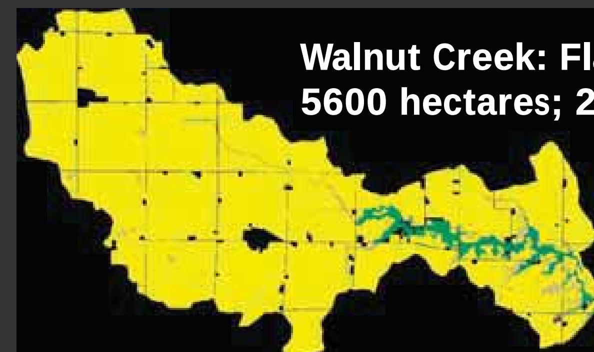
To consider how to alleviate hypoxia in the Gulf, improve local water quality and biodiversity, and support quality of life in the Corn Belt, **we designed normative alternative scenarios and interpreted them as alternative future landscape patterns for small Iowa watersheds, and assessed the performance of those FLPs.** Santelmann, et al. EPA-NSF #R8253335-01-0. 1996.

How can normative designs for small watersheds help to alleviate the continental scale causes and consequences of hypoxia?





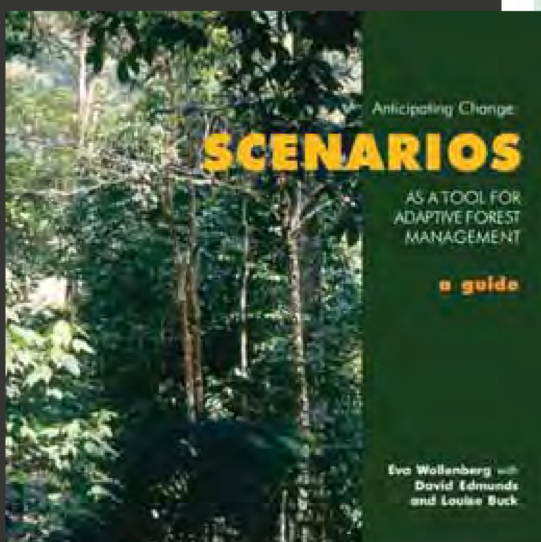
Walnut Creek: Flat and 5600 hectares; 22 sq mi

Buck Creek: Rolling and 8800 hectares; 34 sq mi

Normative scenario - Describes what *should* be rather than what is likely to be or could be

Construct a normative scenario from societal values about the desirability of goals, then innovate based on scientific judgment to envision how goals might be achieved.

Objectives	Scenarios	Projections	Visioning	Pathways
1. Planning collaboratively			★	★
2. Understanding uncertainty and complexity	★			
3. Identifying possible future problems	★	★		
4. Envisioning a desired future			★	
5. Reaching consensus			★	★
6. Encouraging participation	★	★	★	★
7. Developing planning capacity	★			★
8. Conflict resolution	★		★	
9. Short-term thinking		★		
10. Long-term thinking	★		★	



Correct citation: Evans, K., Velarde, S.J., Prieto, R., Rao, S.N., Sertzen, S., Dávila, K., Cronkleton P. and de Jong, W. 2006. Field guide to the Future: Four Ways for Communities to Think Ahead. Bennett E. and Zurek M. (eds.). Nairobi: Center for International Forestry Research (CIFOR), ASB, World Agroforestry Centre. p.87. URL: http://www.asb.cgiar.org/ma/scenarios

Small watersheds are the scale of farming, where innovations are adopted.

"Efforts to remove or reduce nutrients through management scenarios generally are more effective at the source of nutrient loads in smaller streams…

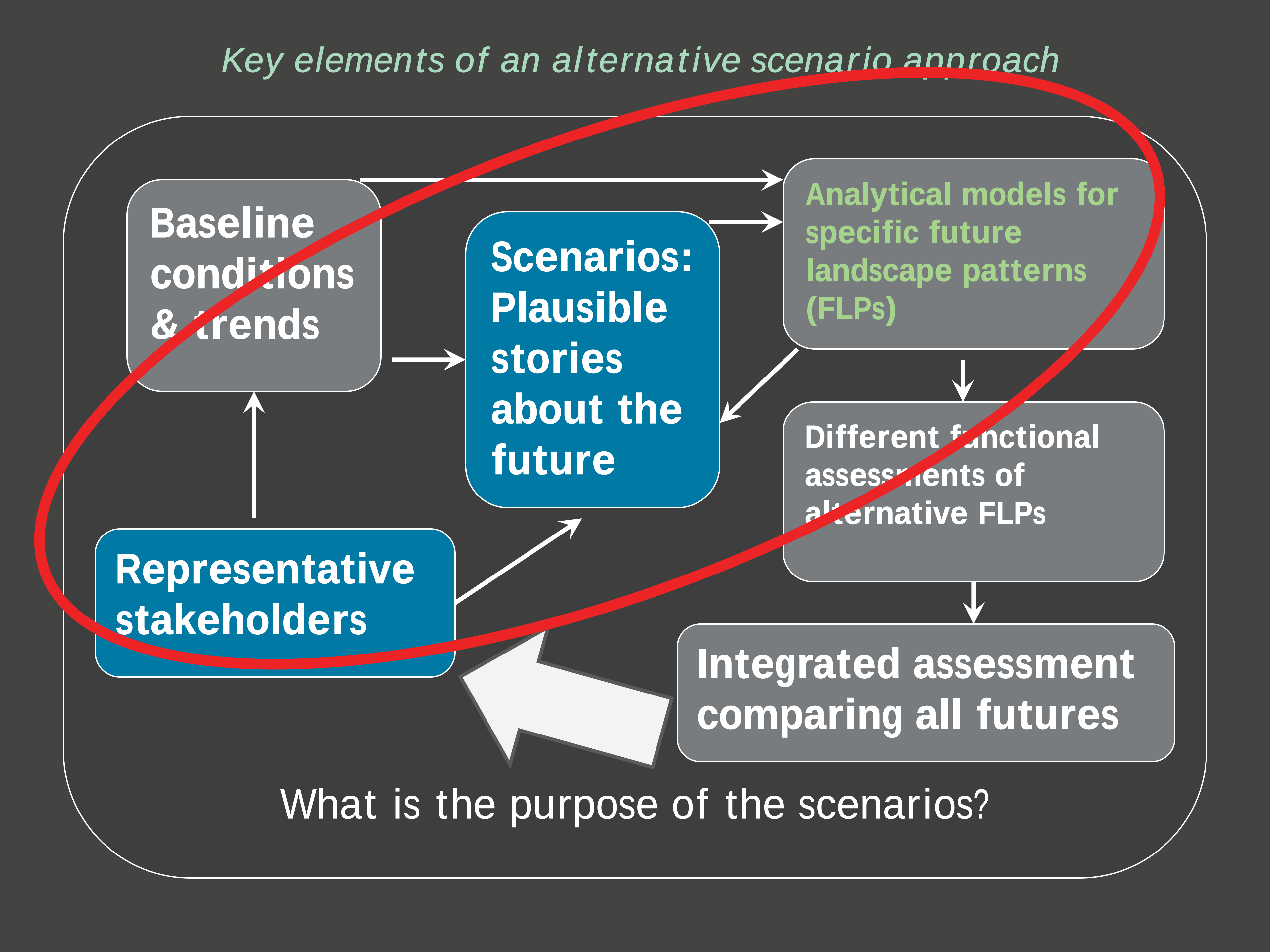
National Research Council 2008

Small subwatersheds will provide a relevant scale for meaningful and interpretable results. "Demonstrations of adaptive management within a small subwatershed may enhance practice adoption…"

EPA SAB Hypoxia Action Panel 2008

"For changes to be effectively implemented, they must be adopted by individual farmers at the local scale…

Doering et al. 2007


Key elements of an alternative scenario approach
Baseline conditions & trends
Scenarios: Plausible stories about the future
Analytical models for specific future landscape patterns (FLPs)
Different functional assessments of alternative FLPs
Representative stakeholders
Integrated assessment comparing all futures
What is the purpose of the scenarios?

Compared with the present baseline,
3 alternative scenarios:

1. High commodity production
2. High water quality
3. High biodiversity

FUTURE LANDSCAPE PATTERNS

A future is a specific applied outcome of one scenario that can be produced as a land allocation model.

For landscapes, alternative futures are explicit, spatially-specific representations of landcover patterns: maps, simulations, visualizations, rather than only quantitative outcomes.

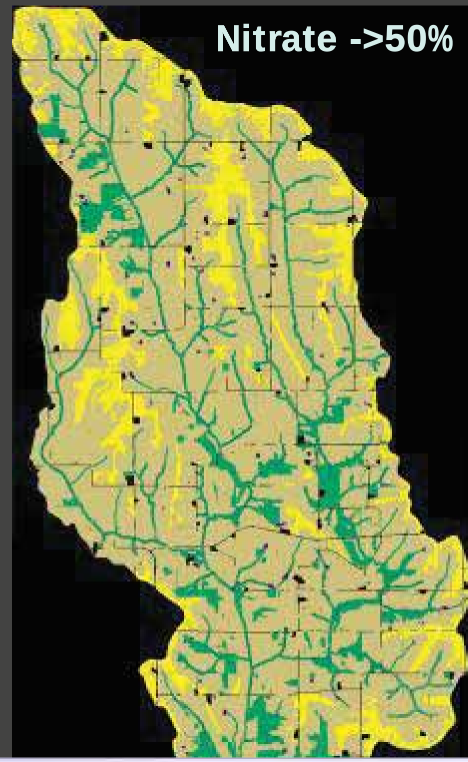
Designing alternative futures points to new combinations of familiar practices and enterprises as well as innovations that are different from past practices.

Nassauer and Corry. 2004.
Normative scenarios for landscape ecology.
Landscape Ecology 19: 343-346.

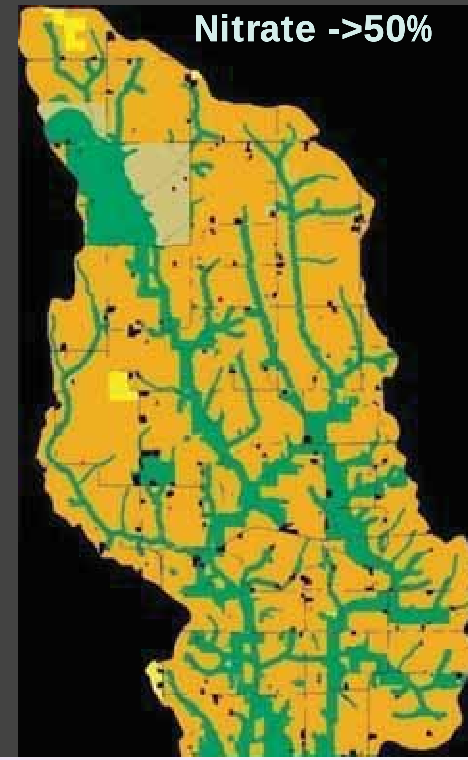
Our team of 25 scientists compared and integrated multiple measures of cultural, ecological and economic performance for each future – including water quality.

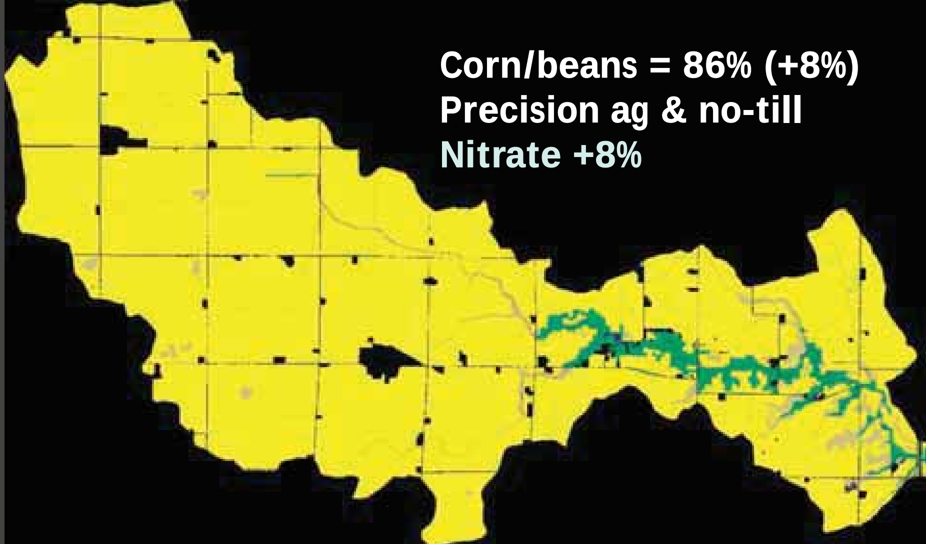
1 **Corn/beans = 62% (+ 38%)**
Precision ag & no-till

2 **Corn/beans/oats= 12% (-81%)**
Prec. ag, no-till, pasture

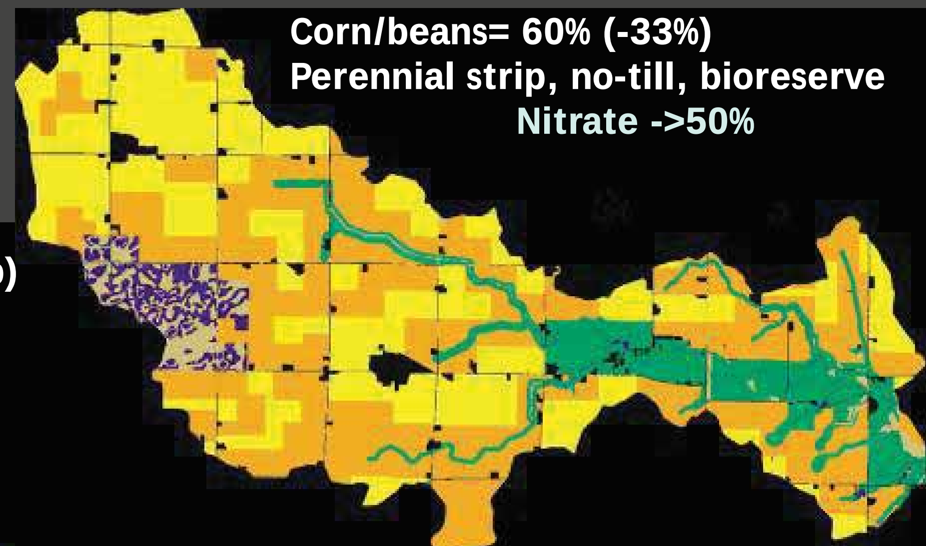


3 **Corn/beans= 42% (-27%)**
Perennial strip, no-till, bioreserve

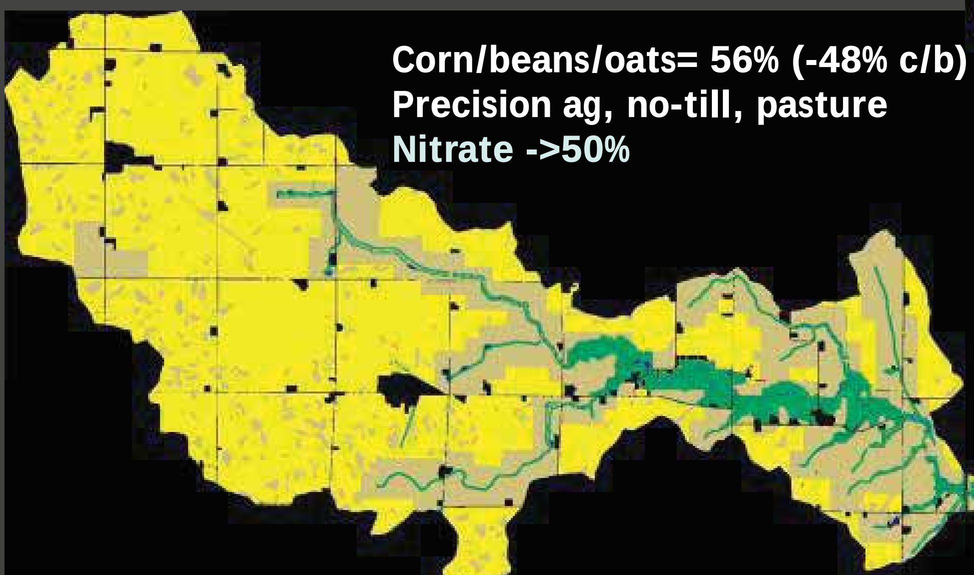




1: commodity production



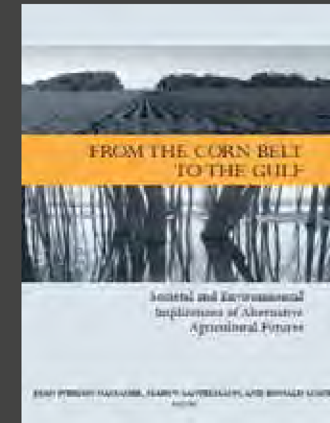
3: biodiversity and perennials

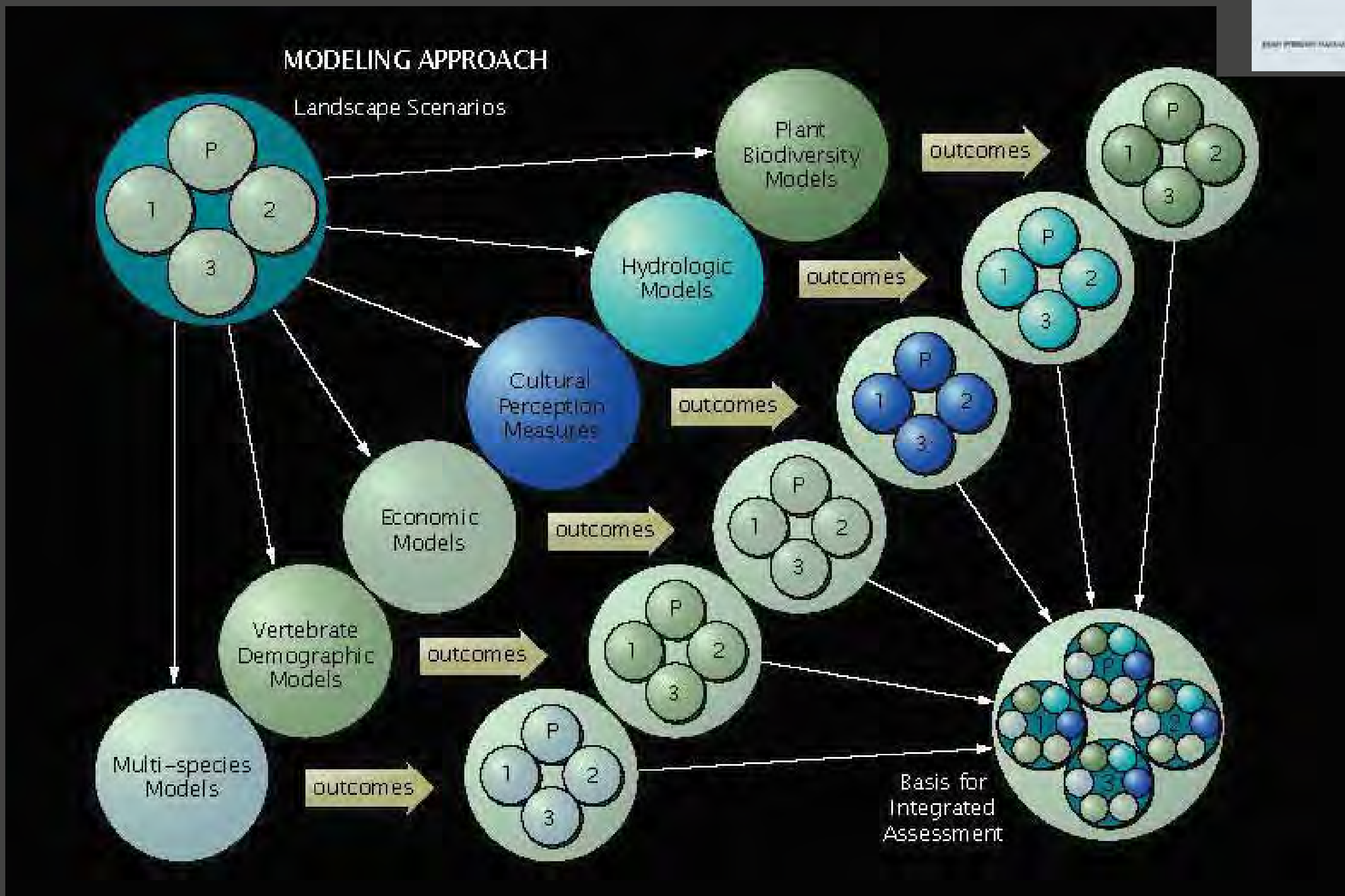


2: water quality and pasture

Assessing Alternative Futures for Agriculture in Iowa, USA.
Landscape Ecology 19: 357-374. 2004.

Santelmann, M.V., White, D., Freemark, K., Nassauer, J. I., Eilers, J. M., Vache, K B., Danielson, B.J., Corry, R.C., Clark, M. E., Polasky, S., Cruse, R.M., Sinfeos, J. Rustigan, H., Coiner, C. Wu, J., Debinski, D.





Assessment measures and models

Water quality: SWAT (Soil and Water Assessment Tool (Arnold et al. 1995) was used to evaluate scenarios for water quality response (Vaché et al. 2002), supplemented by EPIC.

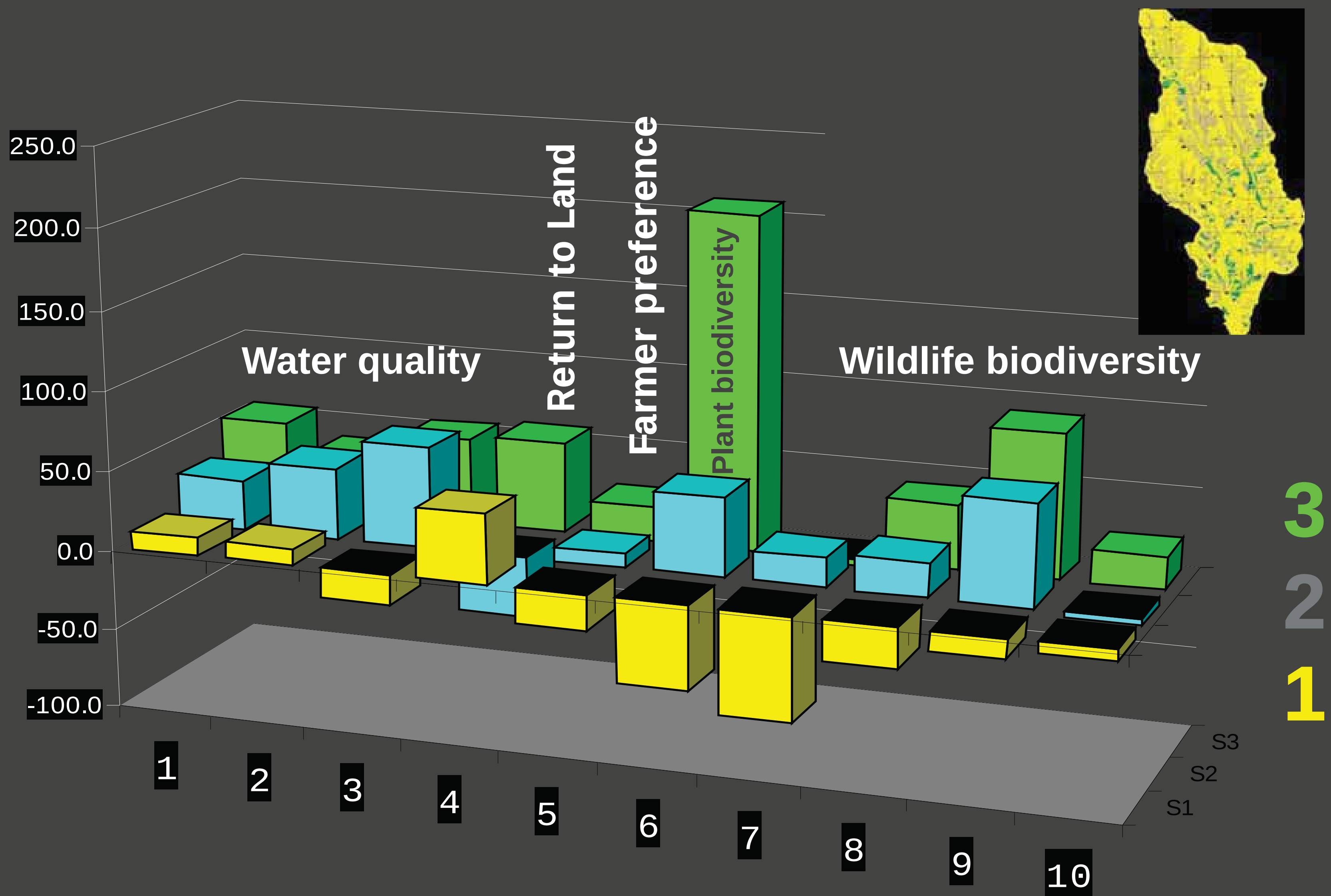
Return to Land: EPIC model (Erosion Productivity Index Calculator (Williams et al. 1988) was used to calculate return to crop yields.

Public preference: spatially explicit area-weighted model for determining landscape preference, based on statistical estimate from farmers' ratings (Nassauer, Corry, and Dowdell 2007).

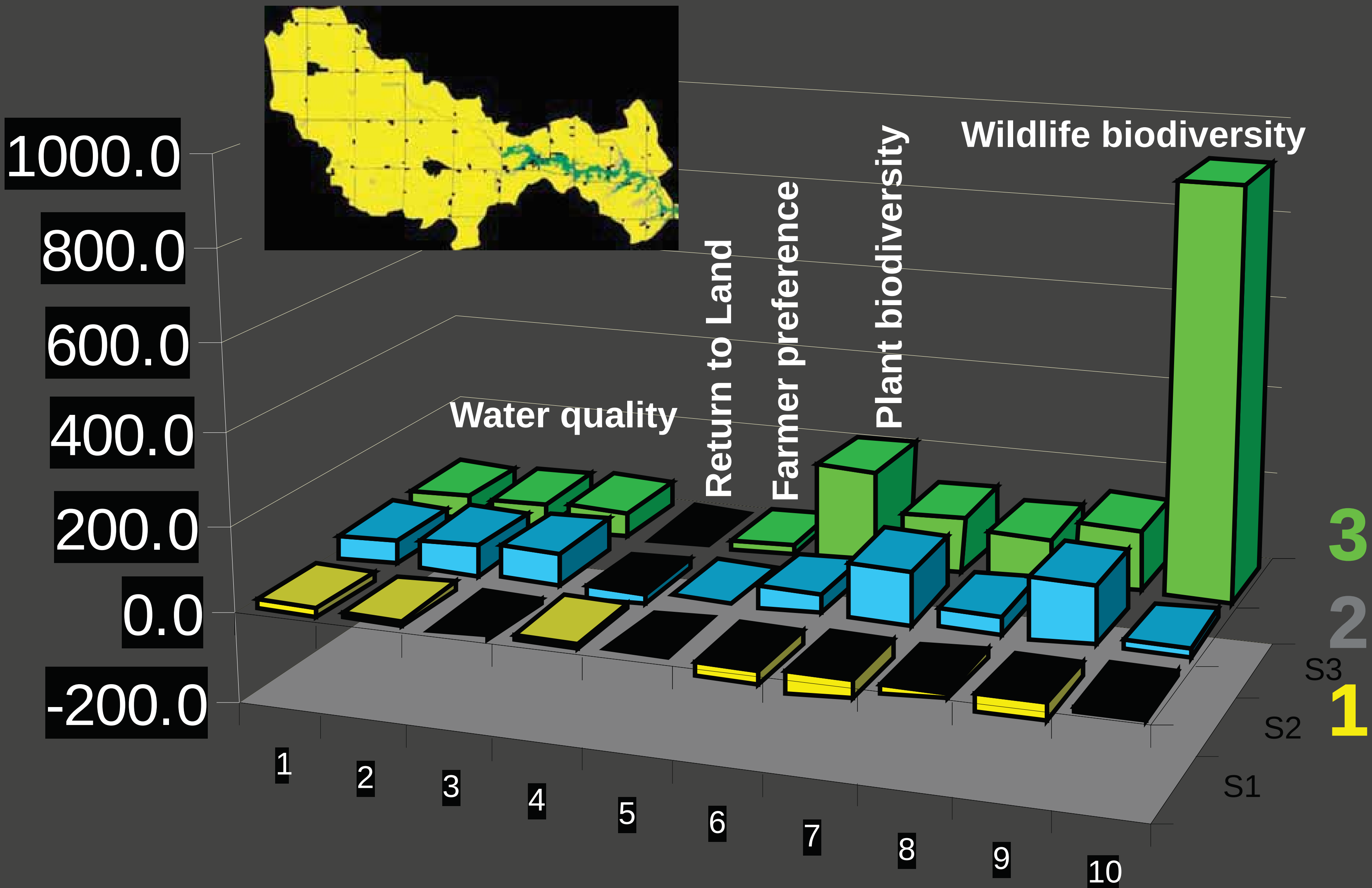
Biodiversity 1: statistical estimate of change in habitat area, weighted by habitat quality (White et al. 1997), for all butterfly and non-fish vertebrate species that occur in central Iowa, or by estimated abundance in that habitat (Eilers and Roosa 1994) for all plant species that occur in central Iowa (White et al. 1999).

Biodiversity 2: spatially explicit population models (SEPMs) to assess the impact of changes in land use and management on small mammal species of interest

Biodiversity 3: landscape pattern metrics (LPMs) to assess changes in habitat pattern for small mammal species



Buck Creek integrated assessment

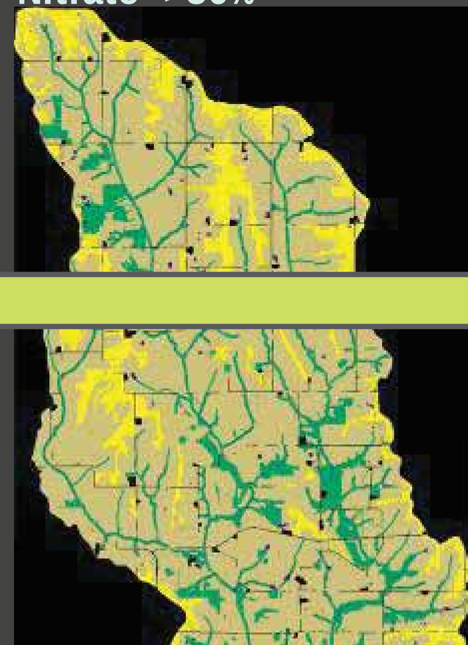


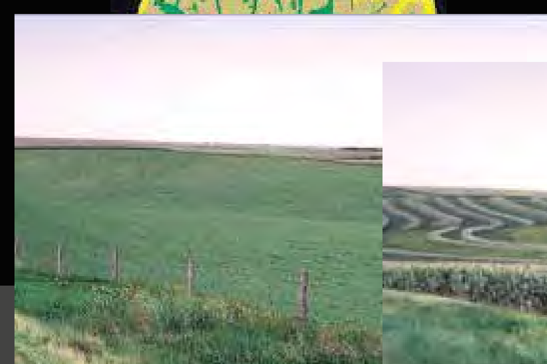
Walnut Creek integrated assessment

Summary of integrated assessment rank

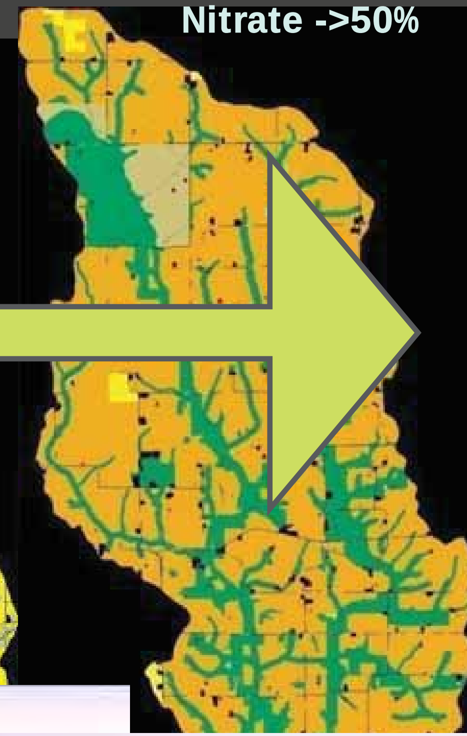
1 Corn/beans = 62%
Precision ag & no-till
Nitrate +19%

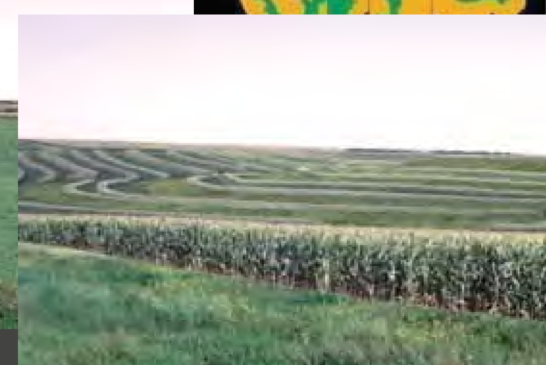
2 Corn/beans/oats= 12%
Prec. ag, no-till, pasture
Nitrate ->50%





3 Corn/beans= 42%
Perennial strip, no-till,
bioreserve
Nitrate ->50%





Science-based Trials of Row-crops Integrated with Prairies **STRIPS Project.** Iowa State University. E.g.,

Matthew J. Helmers, Xiaobo Zhou,* Heidi Asbjornsen, Randy Kolka, Mark D. Tomer, and Richard M. Cruse. 2011 Sediment Removal by Prairie Filter Strips in Row-Cropped Ephemeral Watersheds, Journal of Env. Quality 41

V. Hernandez-Santana et al. 2013. Native prairie filter strips reduce runoff from hillslopes under annual row-crop systems in Iowa, USA Journal of Hydrology 477

Results are similar in these other scenario studies with different foci:

Two central Minnesota watersheds

Boody, G. et al. 2005. Multifunctional agriculture in the United States. **Bioscience 55:1: 27-38.**

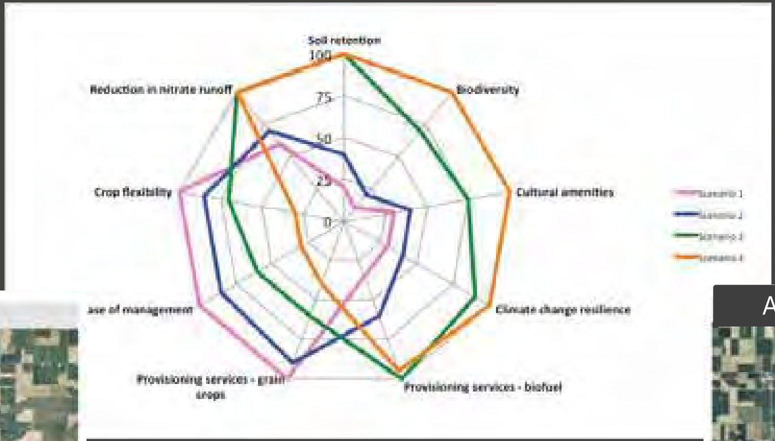
Many watersheds with headwaters in adjacent W. Iowa counties

Burkart, M. D. et al. 2005. Impacts of integrated crop livestock systems on nitrogen dynamics and soil erosion in western Iowa watersheds**. Journal of Geophysical Research 110.**

What about alternative scenarios for perennial biofuel enterprises in the Corn Belt?

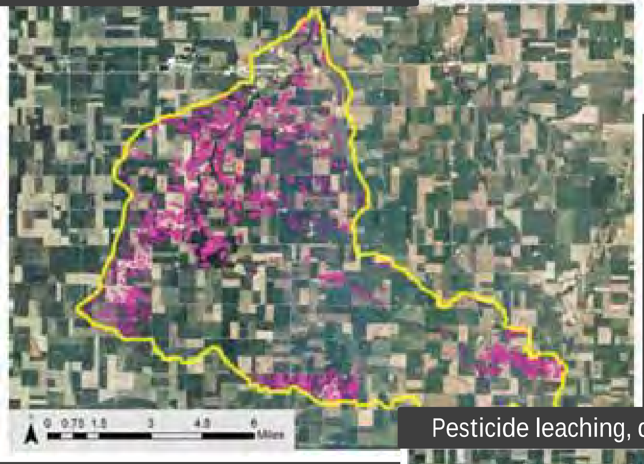
Indian Creek Perennial Biofuel Scenarios and Alternative Future Landscape Patterns:

Land most suited to perennial cropping enterprises

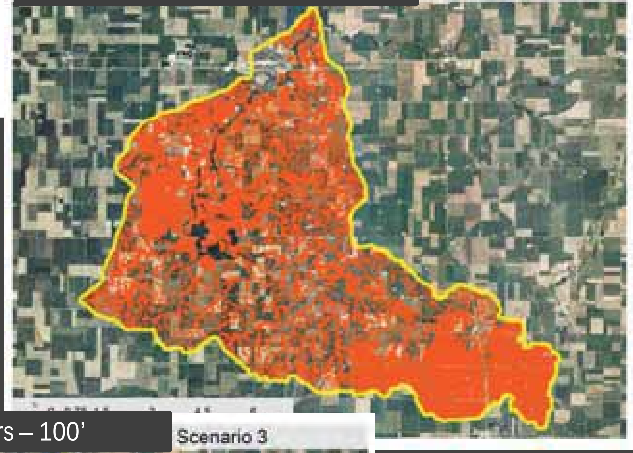


Hypothesized ecosystem services

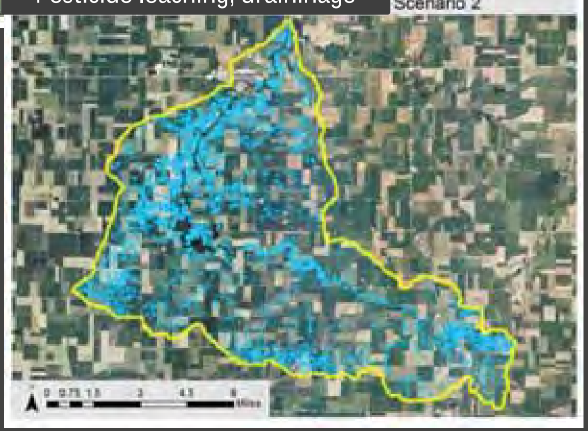
Convenience, Productivity, Nitrate



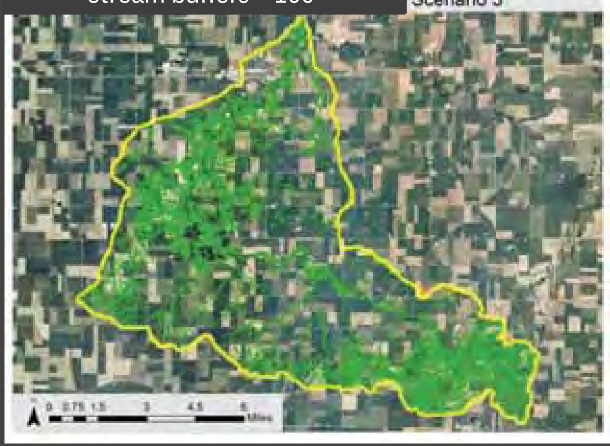
Agroforestry for biodiversity



Pesticide leaching, draininage



Stream buffers – 100’



Scenario 1

Scenario 2

Baseline

Scenario 2

Scenario 1

Scenario 4

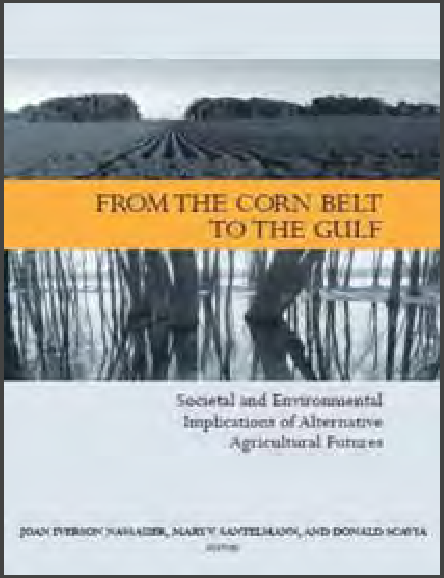
Image: Assoc for Temperate Forestry

Baseline

Scenario 1

Scenario 3

Understanding what local stakeholders know and value is essential



We conducted in-depth on-farm interviews with 32 Iowa farmers in 1998. As part of the interview, they sorted images according to what would be "best for the future of the people of Iowa" in 2025.

Nassauer, Corry, and Dowdell. 2007. Farmers Perceptions.
In **From the Corn Belt to the Gulf.** RFF Press.

2.53

3.22

1997 base

1.47

2.66

Scenario 1-
Commodities

3.56

3.56

Scenario 2-
Water Quality

3.78

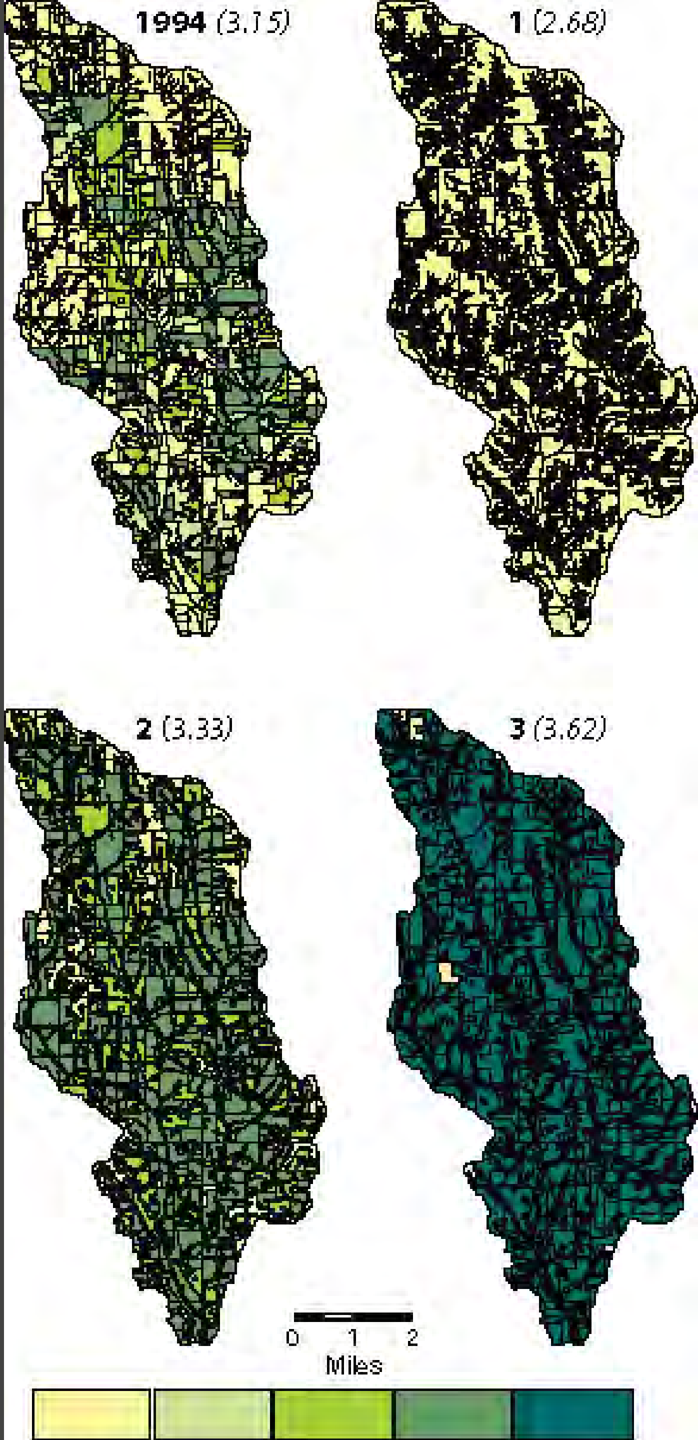
Mean rating of these images by Iowa farmers

Scenario 3-
Biodiversity

We linked farmers' preference data with GIS spatial data by applying farmers' ratings to landcovers, and weighting landcover rates by area within each watershed.

For both watersheds, the order of farmer preference was:

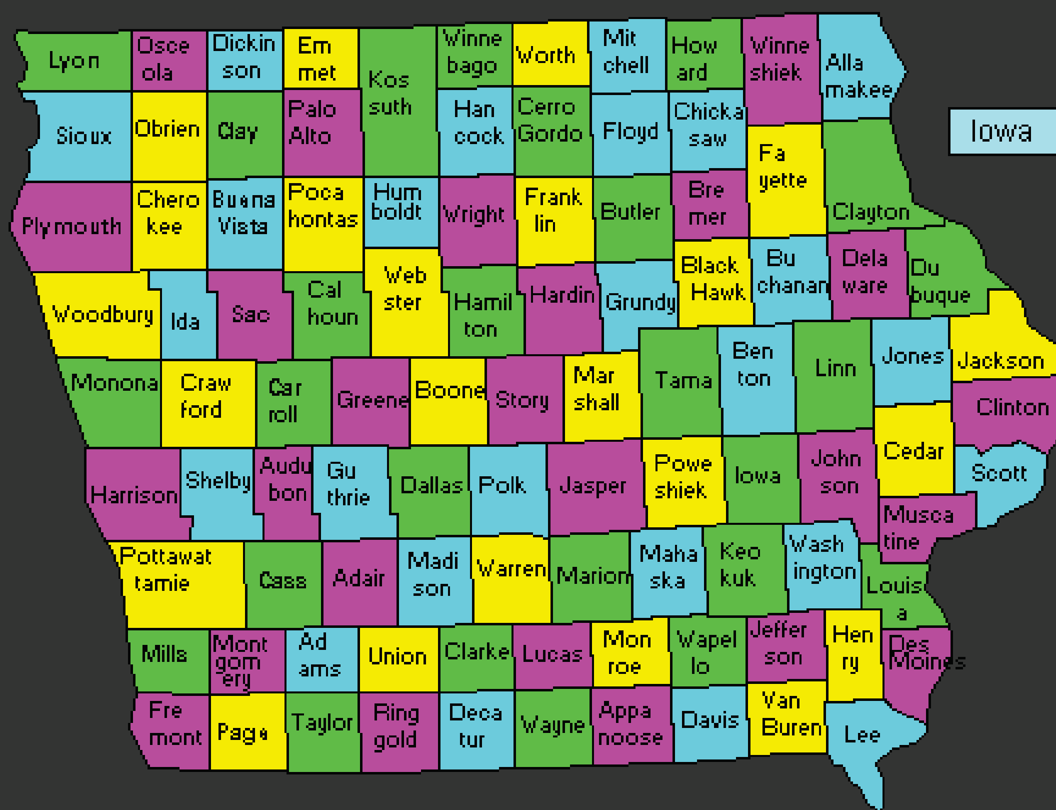
Scenario 3 – Biodiversity
Scenario 2 – Water Quality
Present landscape
Scenario 1 - Production



What about a more representative sample of farmers?

With ISU CARD and cooperation from NASS, we conducted an image-based web survey of 549 Iowa farmers from Nov. 2006 – Sept. 2007. Responses were evenly distributed across Iowa’s 99 counties.

Nassauer, J. I., J. A. Dowdell, Z. Wang, D. McKahn, B. Chilcott, C. L. Kling and S. Secchi. 2011. Iowa farmers' responses to transformative scenarios for Corn Belt agriculture. Journal of Soil & Water Conservation 66:18A-24A.



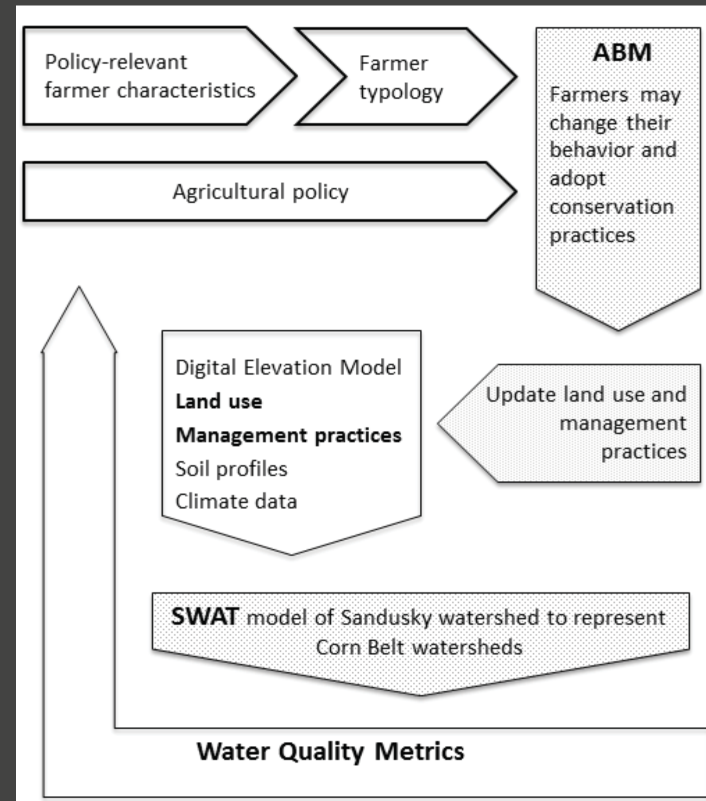
Perceptions of investors compared with other farm operators

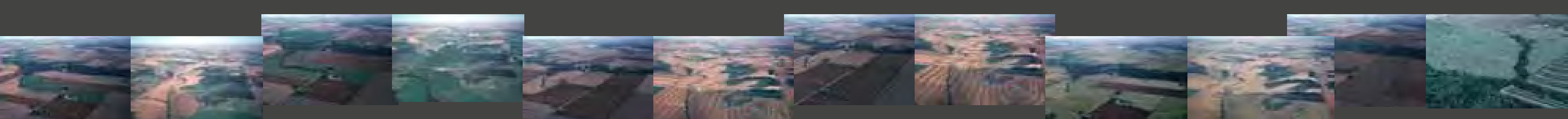
We investigated whether farmers of different ages, retirement status, with different farm sizes, HEL land, CRP participation or different land tenure arrangements had different perceptions. The only significant differences were between investors and other farm operators.

Farmers see all the alternatives EXCEPT the current farm program as significantly more difficult to manage and less profitable than investors do.

These different farmer/investor perceptions were used to populate agent-based models (ABMs) of farmer conservation behavior in the Sandusky Watershed, OH.

(Daloglu,I., Nassauer,J.I., Riolo,R., Scavia, D. In Press. 2014. An Integrated Social and Ecological Modeling Framework - Impacts of Agricultural Conservation Practices on Water Quality. *Ecology and Society.*)





Alternative Future Scenarios

Walnut Creek

Buck Creek

Farm Program

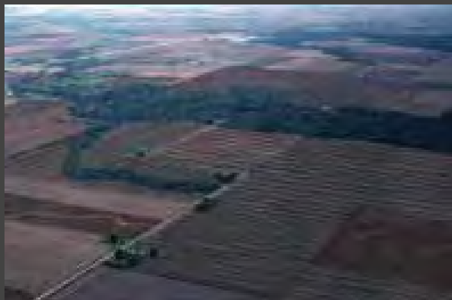
Scenario 1: Current Farm Program This is the current farm program. No restrictions on tillage, crop rotation or any other management operation or practice, other than those currently required (such as conservation compliance requirements, manure management plans, etc.). No restrictions on pesticide or fertilizer.

Scenario 2 : Rotational Grazing: This farm program supports partial conversion of cropland, that is HEL or near streams, to pasture with rotational grazing. If there are waterways within the fields, the waterways must be protected from cattle. Herd size and type can be chosen by the farmer. No restrictions on pesticide and fertilizer.

Alternative Future Scenarios

Walnut Creek

Buck Creek



Farm Program

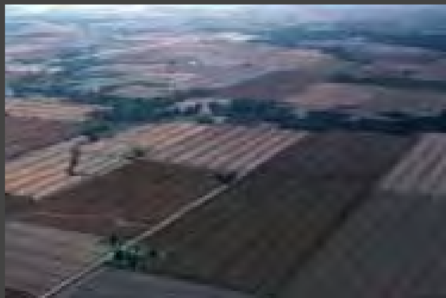
Scenario 3 : Biodiversity Reserves. 19'perennial /59'annual strips: This farm program purchases HEL or wetlands for biodiversity reserves of about 640 acres in every township. Reserves enhance habitat and water quality. The program also supports converting HEL acres to rotating strips of corn and soybeans (59 ft. wide) that alternate with non-rotating perennial prairie mix strips (19 ft. wide). Prairie seed from the strips could be marketed. No tillage restrictions for non-HEL acres. Reduced tillage requirements continue for HEL acres. No restrictions on pesticide and fertilizer.

Scenario 4: Biofuel Perennial crop

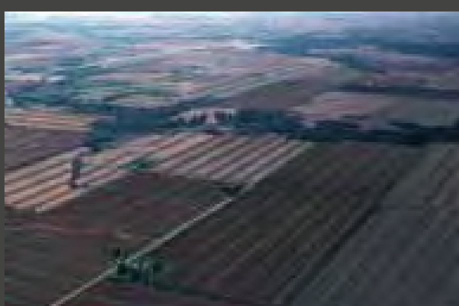
This farm program provides support for converting some or all cropland to native perennial cover, such as switchgrass, that is harvested for biofuel. No restrictions on pesticide and fertilizer.

Alternative Future Scenarios

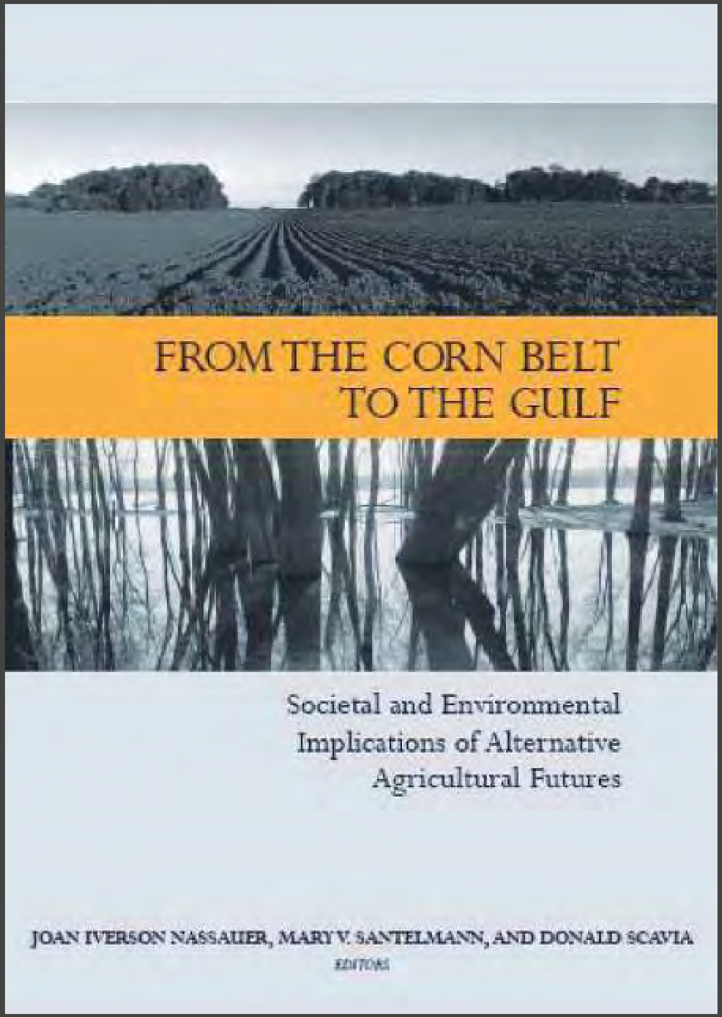
Walnut Creek | **Buck Creek** | **Farm Program**




Scenario 5.15' Perennial/ 120' annual strips: This farm program provides support for strips of annual crops alternating with perennial plant strips. Perennial strips = 15 ft wide, crop strips = 120 ft. wide. No restrictions on choice of crop rotations in the annual strips. No tillage restrictions for non-HEL acres. Tillage restrictions and BMP's remain on HEL acres. No restrictions on pesticide or fertilizer.




Scenario 6. 30' Perennial/ 120' annual strips: This farm program provides support for strips of annual crops alternating with perennial plant strips. Perennial strips = 30 ft wide. Crop strips =120 ft. wide. No restrictions on the choice of crop rotation in the annual strips. No tillage restrictions for non-HEL acres. Tillage restrictions and BMP's remain on HEL acres. No restrictions on pesticide and fertilizer.



Using an alternative future landscape design approach can help us learn if

PERENNIAL BIOFUELS

could help to protect environmental quality, and help us engage farmers in determining how to employ perennial biofuels as part of farming systems.

http://www-personal.umich.edu/~nassauer/rural_sheds.html