Different futures for farmland and the Gulf

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For related publications, see:
http://www-personal.umich.edu/~nassauer
30 years of science was assembled in the Integrated Assessment. To support a Federal-State-Tribal Action Plan.

Could agriculture be different in the future?

*Modeling Effects of Alternative Landscape Design and Management on Water Quality and Biodiversity in Midwest Agricultural Watersheds.* Santelmann, et al. EPA-NSF #R8253335-01-0.

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**Action Plan**

for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico

Mississippi River/Gulf of Mexico Watershed Nutrient Task Force

January 2001

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**FROM THE CORN BELT TO THE GULF**

Societal and Environmental Implications of Alternative Agricultural Futures

JOAN IVerson NASSAUER, MARY V. SANTELMANN, AND DONALD SCAVIA
Gulf of Mexico Hypoxia

Rabalais, et al.
Potential N Reduction:
Overall 40% reduction is possible

Data Source: Mitsch et al. 1999, 2001; CENR 2000
## Costs-effectiveness of Actions

<table>
<thead>
<tr>
<th>Action</th>
<th>Unit Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edge-of-Field Losses 20%</td>
<td>0.88</td>
</tr>
<tr>
<td>Precise Fertilizer Use 45%</td>
<td>2.85</td>
</tr>
<tr>
<td>Wetlands 5M acres</td>
<td>8.90</td>
</tr>
<tr>
<td>Riparian buffers: 19M acres</td>
<td>26.00</td>
</tr>
<tr>
<td>Tertiary treatment</td>
<td>~40</td>
</tr>
</tbody>
</table>
Scientific Assessment

- Hypoxic area is very large; doubled since 1993
- Significant fishery resources are at risk

- River N load is main long-term driver of hypoxia
- N load is > 3X that of 1950’s
- Most N sources are agricultural non-point
  - 90% of nitrate inputs from non-point sources.
  - 56% of nitrate enters system north of Ohio River.

- It’s possible to reduce loads by 40%
- Economic and spatial choices = flexibility for policy
How could this work on the ground?
We developed 3 alternative policy scenarios in two Iowa watersheds. Then we assessed their environmental and societal performance.

Walnut Creek: Flat and 5600 hectares; 22 sq mi

Buck Creek: Rolling and 8800 hectares; 34 sq mi
3 key ways to reduce nutrient loads:

- Use fertilizer more efficiently.
- Keep it on the land.
- Remove it in wetlands.
Compared with the present, the 3 alternative scenarios, shown in Walnut Creek, aimed for:

1. **Commodity production, or**
   - Comprehensive use of precision agriculture
   - Increased area in corn-bean rotation by 8-38%

2. **Improved water quality, or**
   - Introduces pasture/alfalfa near fenced streams
   - Widens stream buffers to 15 m
   - Creates upland detention wetlands and off-channel wetland storage

3. **Enhanced biodiversity**
   - Increased area in perennial grasses to more than 20%
   - Widens stream buffers to 30 m
   - Creates long-term wetland and upland bioreserves that detain run-off

*Santelmann, et al. EPA-NSF #R8253335-01-0.*
• Relatively flat watershed of prairie pothole topography
• Thick glacial till soil of the Des Moines Lobe of the Wisconsin glaciation (approximately 12,000 BP). Rich in organic matter and natural fertility.
• Since tile drainage, nearly all the watershed (83%) has been cropped, presently in corn and soybeans.
Buck Creek
8,790 ha

- More highly dissected. Southern Iowa Drift Plain of the pre-Illinoian glaciations (more than 300,000 BP)
- Soils are loess derived and more prone to erosion.
- Oak woodlands and prairie openings before European settlement.
- Corn and soybeans with hay (45%) on river bottomland, top plateau. Grazing (20%) and woodlands (9%) on slopes.
We modeled the futures using the same kind of data that the USDA might use to determine program eligibility - 1995 landcover in 40+ ag mgmt. classes interpreted from aerial photos and ground-truthed in 1996. ISPAID soils data base: keyed to HEL and Corn Suitability.
We used these data to model 3 alternative scenarios for each watershed - compared with the present. From the GIS data, we developed numerous digital imaging simulations of landscape appearance for each future.
Then, a team of 25 scientists compared and integrated multiple measures and models of cultural, ecological and economic performance for each future.

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

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

- Corn/beans = 42%
  - Perennial strip, no-till, bioreserve
  - Nitrate ->50%
Scenario 1: production
Corn/beans = 86%
Precision ag & no-till
Nitrate +8%

Scenario 2: water quality
Corn/beans/oats = 56%
Precision ag, no-till, pasture
Nitrate ->50%

Scenario 3: biodiversity
Corn/beans= 60%
Perennial strip, no-till, bioreserve
Nitrate ->50%

Vache et al. in
FROM THE CORN BELT
TO THE GULF
MODELING APPROACH

Landscape Scenarios

Plant Biodiversity Models

Hydrologic Models

Cultural Perception Measures

Economic Models

Vertebrate Demographic Models

Multi-species Models

Basis for Integrated Assessment

outcomes
We conducted in-depth on-farm interviews near our study areas in 1999. 32 Iowa farmers rated (1-5) 20 images on what would be “best for the future of the people of Iowa”. In 2007, we (Nassauer and Kling) surveyed 550 Iowa farmers on their perceptions of the same futures - as well as four additional scenarios.
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Rating 1998 Base</th>
<th>Rating</th>
<th>Rating 1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1 -</td>
<td>2.66</td>
<td>3.22</td>
<td>3.56</td>
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<tr>
<td>Commodities</td>
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<tr>
<td>Scenario 2 -</td>
<td>1.47</td>
<td>2.66</td>
<td>3.56</td>
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<tr>
<td>Water Quality</td>
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<tr>
<td>Scenario 3 -</td>
<td>2.53</td>
<td></td>
<td>3.78</td>
</tr>
<tr>
<td>Biodiversity</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Mean rating of these images by Iowa farmers in 1999
Making image ratings applicable to GIS mapping

GIS-based design for a scenario

Images are generated to represent landcovers in each future

Ratings are mapped for each landcover and weighted by area in that landcover
We linked perception 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
Rank of the scenarios for: Water quality

BEST

1

2

3

Landscape Scenario 1

Landscape Scenario 2

Landscape Scenario 3

Water Quality Classes
Rank of the scenarios for:
Market return to land from production

BEST

1  3

Landscape Scenario 1  Landscape Scenario 3
Rank of the scenarios for:

Biodiversity

BEST

Landscape Scenario 2

Landscape Scenario 3
Return to land

water quality, biodiversity, preference

BEST

1

Return to land

3
Changes in Corn Belt farming could dramatically reduce the 5000 square mile “dead zone” in the Gulf of Mexico.

Agricultural policy could help to achieve these changes including:

- More complete adoption of traditional and innovative conservation practices
- Precision farming
- Upland and wetland habitat restoration
- Perennial crops - properly managed for conservation value